NATIONAL PETROLEUM NEWS

TECHNOLOGY DEPT.

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JAN 9

Col. Burford, Texas Independent, Runs POL Show in France

By Warren C. Platt

PARIS—A hard-driving force in getting petroleum supplies to the American armies over here, is Col. Freeman W. Burford, for 25 years an Independent oil man, producer, refiner and marketer from Louisiana and Texas. Since last winter and the final planning of the invasion of France, he has been the chief petroleum officer in the ever-growing Communications Zone of the Army Supply Services. (*Other POL articles start on p. 4*)

Col. Burford is as picturesque "up front" at the battlefields as he was in the oil fields, and he spends a good bit of his time cruising up there in a jouncing jeep that exposes one not only to all the holes in the road but to wind and rain as well. The "tin hat" has replaced his familiar West Texas headgear but the big black cigar is still there. On inspection trips to the POL depots his usual parting remark to the captain in charge, is the same "keep 'em rolling" as he gave to his men in refinery and field in Texas.

He runs the show with the same energy and drive here as he did his drilling rigs back home.

Col. Burford's work in this invasion has been recently recognized by the Army, first in making him a full colonel and second in awarding him the Bronze Star medal for exceptional services in handling and overcoming oil supply problems.

Col. Burford began in the oil industry, a young man, as an Independent and he early had his own company, the old Crystal Refining Co. of Shreveport, La. Later he built the East Texas Refining Co. with headquarters at Dallas.

Col. Burford volunteered for government service two years ago. He began in the transportation service at New York. Last winter he came to England ahead of a group of oil experts many of whom are now on his staff. As plans for handling oil developed, Col. Burford found himself heading a small but growing group that was to oversee the supply and transport problems from the main base, then England but now Northern French channel ports, up to the fighting armies.

In this work he brought together the many groups that were making plans for their own part in the invasion and which plans included oil for their own use. From these various groups Col. Burford developed a master plan.

Col. Freeman W. Burford . . . 'tin hat' replaces his Texas Stetson

This early loose-knit advisory group has become an operating unit which speaks through Gen. Stratton, commanding the supply services, or "G-4," and then through Gen. Lee in command of the entire COM Z area and its activities. It has been the task of this oil group, now grown to more than two score, to correlate the many Army services that have to do with oil supply and also to help the consuming services in estimating their requirements and in sufficient time to fill them. The job includes not only the procuring of oil supplies but overseeing the movement of tankers, tank cars, tank trucks, the procurement of material for pipe lines and their construction and the supervising of storage and the storage program. Every drop of petroleum products, more than 7,000,000 bbls. of gasoline and Diesel fuel alone, that our Army has used in the invasion of France has moved through this group. In addition the group has supervised the procurement and installation of the handling facilities.

All of this is a sizeable job in peace time but in war with new conditions constantly arising, with many views of many men to make track, it is a truly great job. We join in the felicitations of the Army in the good work Col. Burford and his group have done. And we know that when all the facts can be told the oil industry will likewise heartily agree.

R v.37 Ja-Mr.1945

This Post-War Decision

can be made now
–with assurance!

MANY DECISIONS affecting post-war station operation must be delayed until VE day or later. Many more can be made now. Among the latter is the selection of service station pumps. The same factors that led thousands of buyers to choose Tokheims before the war will be present when gasoline pump sales are resumed in quantity. And to the famed Tokheim features of appearance, dependability, accuracy and low maintenance cost, can be added the great advantage of dealing with a stronger organization, trained and disciplined by war to build with proved skill and efficiency.

Certainly you can decide now—and we believe you should—to put Tokheim on your islands when the day of victory comes.

TOKHEIM OIL TANK AND PUMP CO.
Designers and Builders of Superior Equipment
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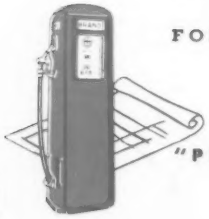

"PUT TOKHEIM IN YOUR POST-WAR PLANS"

KEEP FIGHTING—BUY WAR BONDS

TECHNOLOGY

Facts and Flashes

From the
ETHYL CORPORATION
Chrysler Building, N.Y.C.

The machinery for making automobiles was stopped by the red light of war . . . but one kind of automotive progress actually was speeded up.

Strange as it seems, during the very years when no civilian passenger cars were being built, automotive progress was being made.

How? The answer is surprisingly simple...if you keep one thing in mind. Just remember that an automobile engine and the gasoline it uses are not separate things, but two parts of a single unit—automotive power.

While automobile manufacturers couldn't introduce new passenger car engines during the war years, the petroleum industry was under constant pressure to produce better and better gasoline. The equipment which was installed to produce vast quantities of high-octane aviation gasoline will be adapted to the manufacture of finer motor gasoline for postwar use.

The tremendous wartime progress in gasoline refining can, in a sense, be considered automotive progress. Automotive engineers will be able to design engines that take advantage of this improved gasoline to create better automobiles. These postwar cars will be greatly improved in performance and economy.

* * *

A 2,000-MILE PIPELINE from Calcutta to the central Yunnan airfield is nearing completion. Already this record-breaking pipeline is delivering many thousands of tons of oil and gasoline to American installations in the North Burma-Assam combat area. When finished, it will be the longest in the world, over 600 miles longer than the Big Inch in the United States. Chinese economists believe this pipeline will build the Kunming region, source of large quantities of unexploited minerals, into a heavy industrial center after the war.

THE JAPANESE WAR is not expected to be a war on wheels to the same extent as the European war. Within nine months after the Germans surrender—according to recent plans submitted by the Army and Navy—military demand for motor vehicles will be cut more than 60%. Civilian production is expected to take up the slack through the large market already waiting for trucks, buses and farm machinery. Suddenly changing military demands and conditions, however, may upset these predictions overnight.

A GASOLINE-POWERED CONVEYOR for loading baggage and freight on airplanes has been devised and already put into use. It consists of a tractor-mounted "escalator" which can be driven to the plane's cargo hatch. The moving belt is elevated for action by a hydraulic system.

New Year's Message

Petroleum Promises!

By William R. Boyd, Jr.,

President, American Petroleum Institute
Chairman, Petroleum Industry War Council

FORTUNATELY for the prospect of enduring peace in this world there are still a great many people who take promises seriously—who neither make them glibly with indifferent intent, nor readily condone the violation of pledges made by others. Honor and integrity may have become outmoded and despised virtues in some nations of the earth; but this wonderful land of ours, so richly endowed with natural resources, and the home of an enterprising and progressive people, is still one great nation where a pledge is neither casually given nor lightly broken. So it was with those gallant patriots who pledged their lives, their fortunes, and their sacred honor; and so, please God, may it ever remain.

W. R. Boyd, Jr.

In community with the people who compose it and the far greater number whom it serves with the precious heat and energy of petroleum, the American petroleum industry has made a few promises during its brief but impressive existence of 85 years. Although the industry has long preferred to let its performance speak for itself, nevertheless, those promises that have been made have been scrupulously kept.

The grave, continuing urgencies of this war and the onrushing problems of peace now demand from our industries and from our government definite pledges of sustained and unstinted compliance with the insatiable demands of an all-out war, and equally firm commitments to accept realistically the boundless challenges of peace.

For the vast American petroleum industry which is still growing in scope and in service, it can be stated that there exists a firm determination to accept and bear proudly and honorably those inconceivably great responsibilities that have been thrust upon it by the absolute essentiality of its products to modern society. And not unmindful of the full meaning of its pledge to the millions dependent upon it for their transportation, security, safety, comfort, and way of life, petroleum hereby promises:

1. Its continued and complete devotion to America's first and greatest task today: The winning of the war and the securing of an enduring peace.

2. Its unending effort to serve the American people with an always adequate supply of those countless petroleum products that have become so necessary to modern living.

3. Its unceasing acceptance of its responsibility in maintaining and improving the already high standards of employment and opportunity in the petroleum industry.

4. Its unreserved realization and proper discharge of its duties as one of the great basic elements of the nation's economy.

5. Its constant and continued search for new and greater sources of petroleum, more and better petroleum products, and greater opportunities for employment and service—to the end that the American people and their government shall never find within the petroleum industry itself any reason for charging it with dereliction of duty or evasion of responsibility.

These things petroleum promises!

Coming Meetings

JANUARY

Northwest Petroleum Assn., North Dakota and Minnesota section, Radisson Hotel, Minneapolis, Minn., Jan. 4-5.

North Carolina Oil Jobbers Assn., Hotel Carolina, Raleigh, N. C., Jan. 10.

Associated Motor Carriers of Oklahoma, 14th annual meeting, Mayo Hotel, Tulsa, Okla., Jan. 16-17.

FEBRUARY

Kentucky Petroleum Marketers Assn., Brown Hotel, Louisville, Ky., Feb. 13-14.

Missouri Independent Oil Jobbers Assn., Governor Hotel, Jefferson City, Mo., Feb. 14-15.

Iowa Independent Oil Jobbers' Assn., Hotel Fort Des Moines, Des Moines, Ia., Feb. 21-22.

MARCH

Indiana Independent Petroleum Assn., Inc., Indianapolis, Ind., March 21-22.

APRIL

Independent Petroleum Assn., mid-year meeting of the Board of Directors, New Orleans, La., April 9-10-11.

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BULLETINS

3 NEW LUBE PLANTS REJECTED

WASHINGTON—WPB has temporarily denied PAW request for approval of construction of three new aviation lube plants on grounds that presently indicated lube requirements are not firm enough to warrant favorable action.

Involving total production of about 2000 b/d, plants would be constructed by Deep Rock, Consumers Co-operative Assn., and Shell (at Houston). PAW had urged approval of projects to back-stop present aviation lube program.

SODIUM PHOSPHATES FREED

WASHINGTON—WPB has removed all allocation controls from six sodium phosphate chemicals, including two used in oil well drilling—crystal di sodium phosphate and crystal tetra sodium pyrophosphate—whose supply is now described as being "adequate to meet all demands." The board's action was taken by revoking order M-334 (sodium phosphates).

JAP OIL SUPPLY DWINDLES

WASHINGTON — Netherlands government sources have just reported that shipments of oil to Japan from the Dutch East Indies have been dwindling severely for the past year as a result of concentrated Allied bomber attacks which have razed the principal oil refineries at Surabaya, Java, Palembang, Sumatra, and Balikpapan, Borneo.

GILLETTE NAMED TO BOARD

WASHINGTON — Nomination of ex-Senator Gillette, of Iowa, to be the third member of the new surplus property board was sent to the Senate Jan. 3 by President Roosevelt.

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Industry Committee Named for Final Survey of Crude Prices

Facts on Producing Costs To Show if Price Increase Is Due; Bowles Ready To Help, Says OPA View Is Unchanged

NPN News Bureau

WASHINGTON—OPA this week appointed a formal national crude price industry advisory committee to aid in surveying producers' costs, in line with the recent Patman Committee recommendation, so that conclusive facts for and against a nation-wide crude price increase can finally be laid on the table for definite action.

From membership suggestions filed with the price agency by W. R. Boyd, Jr., A.P.I. head and P.I.W.C. chairman, and by the Independent Petroleum Assn. of America and the National Stripper Well Assn., OPA chose the following industry representative to constitute the advisory group:

John G. Pew (Sun) Dallas; J. H. Russell (Gulf) Houston; George Bays (Stanolind) Tulsa; Raymond B. Kelly (Pure) Olney, Ill.; A. C. Rubel (Union Oil Co. of California) Los Angeles; Dr. R. B. Emery (Ohio Oil Co.) Findlay, Ohio; Danna Kelsey (Sinclair Prairie) Tulsa; Charles F. Roeser (Roeser and Pendleton) Fort Worth, Tex.; J. D. Sandefer (National Stripper Well Assn.) Breckenridge, Tex.; N. W. Shiarella (Miller and Shiarella) Owensboro, Ky.

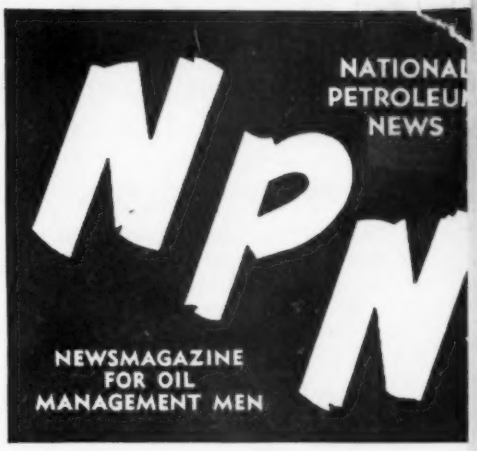
Edwin W. Hayes, Independence, Kans.; C. P. Watson (Seaboard Oil Co.) Los Angeles; W. H. Morgan (R. R. Bush Oil Co.) Long Beach, Calif.; Howard J. Whitehill (Whitehill Oil Corp.) Tulsa; J. P. Coleman (McCarty and Coleman) Wichita Falls, Tex.; Maj. B. A. Hardey (chairman Louisiana Mineral Board) Shreveport; Merle Becker, St. Louis; Gilbert J. Mueller (Argo Oil Co.) Denver; B. Reeser (Barnsdall Oil Co.) Tulsa; J. P. Jones, Bradford, Pa.; H. J. McClure, Alma, Mich.; E. P. Potter (Amerada) New York City; and Carl P. Reistle (Humble Oil & Refining) Houston, Tex.

A questionnaire already has been worked out by OPA's oil price branch to be used in surveying producers' costs. It will be submitted to the national crude committee for suggestions or changes. The questionnaire is expected to be split into two parts: One, seeking necessary "basic" data for computing costs, and the other dealing with more detailed information to be filed with OPA only if the producers so wish.

This second section, or supplement, will give producers full opportunity to present complete data. This is being done so that later, if OPA determines information gathered by the basic questionnaire does not justify a general price increase, producers will not be able to say they were denied opportunity of presenting their situation in detail.

Meanwhile, OPA Chief Bowles issued a formal statement announcing the forthcoming establishment of a National Crude Price Advisory Committee—the first since oil price control was instituted in 1941—to help OPA make a survey of costs "in the crude oil producing industry to determine if existing ceiling

(*Continued on p.* 13)



OPA Makes Progress On Bail-Out Bonus

NPN News Bureau

WASHINGTON — A "bonus" bail-out plan for super-careful dealers is now "in the works" at OPA following a conference between gasoline rationing and enforcement officials and, if adopted, should go far toward enabling dealers completely to wipe out past debits made against their inventories for bad coupons.

General agreement has been reached between these officials in OPA, it is understood, that such an idea is sound and fair and will do much towards cutting the market for counterfeit coupons by encouraging dealers to be extra cautious in accepting coupons from motorists.

Prior to the conference, it had appeared that enforcement officials would oppose the "bonus" idea, first suggested by an industry member at OPA's recent gasoline advisory committee meeting. William Remey, OPA durable goods and fuel enforcement director, had said that while he was not then acquainted with details of the plan, it appeared that it was not sound and might act to legalize a 1% black market in gasoline coupons. He emphasized that his mind was open on the question—"but we will be very careful not to get into anything that will permit a black market up to 1%."

Following a meeting with gasoline rationing officials, however, the opposition of enforcement chiefs melted and they agreed to the tentative formulation of a "bonus" bail-out.

The bonus plan now being considered, it is understood, would give a careful dealer whose bad coupons total less than 1% of his monthly sales, twice the difference up to 1%. In other words, if a dealer's sales in one month total 10,000 gals., and bad coupons accepted represent only 50 gals., or ½ of 1%, he would be allowed the remaining ½ of 1 per cent, plus another ½ of 1%, to apply against past debits not entirely liquidated by present bail-out rules.

OPA Warns Fuel Oil Consumers to Put on Brakes

NPN News Bureau

WASHINGTON — OPA this week warned that fuel oil consumers must curb the present general tendency throughout the country to use more fuel oil than their rations allow and described the problem which is developing on the East Coast as "especially serious."

The rationing agency said there were widespread indications that many householders had dipped too heavily into their fuel oil rations and were burning oil at a rate considerably in excess of what they should have used up to the present point in the 1944-45 heating season.

Cold homes later on this winter, with no extra rations available, will be the inevitable result of overconsumption now, OPA warned. Putting it up to the individual consumer to stay within his ration week by week, the agency repeated recent warnings issued by PAW which emphasized the fact that the supply situation is as critical now as it was during the original shortage in the winter of 1942-43.

On the East Coast, OPA pointed out, where transportation uncertainties have reversed the favorable supply outlook of early fall, distillate stocks are now two million barrels under what they were a year ago. On Dec. 23, they totaled 11,400,000 bbls., against 11,500,000 bbls. at the same point in the last heating season.

In the face of this supply situation the tendency toward over-consumption since the beginning of Heating Period 2—which started Dec. 11 in the Pacific Northwest and Dec. 18 on the East Coast and in the Midwest and the South—appears to be general throughout the rationed areas, OPA said.

Reports indicate that an especially serious problem is developing on the East Coast. Fuel oil suppliers, as well as local boards, have reported extra heavy drains on stocks by householders, and excessive consumer use of "change maker" and other fixed value or "inventory" coupons.

Indications that many consumers are using up their store of fixed-value coupons early in the season, instead of budgeting them to supplement the regular period coupons throughout the heating year, can only mean that some homes are being heated now in excess of what the overall ration allows, OPA said.

With Warren Platt Overseas—

Oil Men in POL Provide Flood of Motor Fuel for Liberating Armies

7,443,692 Bbls. of 'Gas' and Diesel Oil Landed in North France Since D-Day; French Get Small Quantities for Essential Use

By Warren C. Platt

PARIS—Petroleum to guarantee the continual pounding that Gen. Eisenhower recently publicly promised to give the enemy all winter and spring until they quit, is not only on the Continent but large stocks of gasoline for ground and air forces and oil are at strategic points from which they can quickly be supplied to our fighting forces the minute the forces need them.

Mr. Platt

In addition to these most satisfactory military supplies, the incoming flow of petroleum is now large enough to permit the military authorities to allow small, but increasing quantities, of oil to highly essential civilan needs.

These diversions from the military supplies will increase the quantity of food for France, Belgium and Holland and particularly bring food to the hungry cities. Also shivering children and old folks will have the comfort of some hot water and even a bit of building heat. Small supplies (it is hoped they will increase shortly) are being passed out to industries to help get them back into production.

Not only has the petroleum supply in this part of Europe greatly improved but the lines of its transportation not only from England but from all channel ports in France, Belgium and Holland, by pipeline, barge, tank car, tank truck and trucks of Jerrycans, have been greatly increased in capacity and their operating smoothed out. All this most favorable situation on petroleum, the greatest single commodity in volume servicing this war, has been brought about during the comparative lull of the past few months since Gen. Patton made his famous "break through" and then so rapidly drove the enemy back to its own borders in September.

For this excellent condition in petroleum supply the country owes its thanks, not only to the staff, commands and the various service organizations of the Army but, from an oil industry point of interest, also to a large group of its own oil men who are active in important positions in the many POL branches as well as in the engineers, transportation, quartermasters and ordnance corps of the Army itself.

While the oil men have served to a large extent in groups in special oil activities they, at the same time, have been part of the regular army machinery and it is this machinery, in its entirety, that has brought about the successful results in oil supply. Oil and oil men have been given a place on the staff of General Eisenhower at Supreme Headquarters known as SHAEF. (*The story of this POL group will be found on Page 6*).

On the operating side of the Army's machinery and below the generals and as a part of their staff organizations that have the actual handling of supplies in this ever expanding Communications Zone that now stretches across the north half of France, is a group of oil men who have been gathered from all divisions of the American oil industry. Some of these men came to North Africa and England several years ago, others last spring and since while still others have been in military service in the U. S. for some years.

This particular group of oil men that is a unit of the operating staff of the Hq. Communications Zone, European Theater of Operations, U. S. Army (Com Z Etousa) did not come into definite form until last Spring when final planning was begun for the approaching invasion of France June 6. Since then, under this group, the facilities for handling the millions of barrels of petroleum products that have arrived on the Continent, including some for British use, the past five months, have been expanded to large size.

Lieut. Col. Howard C. Pyle Chief Deputy to Burford

At the head of this group is Col. Freeman W. Burford, Independent oil producer and refiner of the Southwest and now of Texas, and Lt. Col. Howard C. Pyle, formerly chief production engineer of the Union Oil Co. of California, is his chief deputy.

How the higher Army officials value the services of this oil group is evidenced by the citation recently given Col. Burford for the Bronze Star Medal. That citation says that Colonel Burford

"—was largely responsible for the united efforts in planning for and later constructing and operating the pipeline system for the distribution of POL on the Continent. To implement the flow of POL products to the Armies, effective methods of distribution of packaged product, bulk POL and materials for the construction of the pipeline and tankage were developed, with the aid of Colonel Burford's skill and experience. By his loyalty and determination of purpose, Colonel Burford has achieved success in his mission and contributed materially to the war effort, reflecting great credit upon himself and the armed forces of the United States."

This citation was followed by his promotion from lieutenant colonel to a full colonelcy.

This, says Col. Burford, is recognition of the work which every oil man has done with the armed forces and they have brought about today's strong petroleum position.

In support of this praise to Col. Burford and his men are some figures as to the size of the job they have been doing and which facts can now be given. In subsequent articles, I will bring the reader up-to-date on the completion of the military pipelines to their originally planned terminal; Lt. Col. W. R. Boyd III, who has had a prominent part in handling the oil supply for the air forces will write of meeting an unbelievably expanding demand. And the writer will report on the handling of petroleum by trucks and waterways over here.

The great size of the job that has been done here is shown by the fact that since "D" day, June 6, 1944, exactly 7,443,692 bbls. of gasoline M. T., "Av" and Diesel oil, have been received in bulk by the U. S. Army on the northern shores of the Continent, have been stored, transported, and most of it packaged. This figure does not include oil products landed in Southern France and in Italy, nor POL brought over in millions of filled 5 gal. Jerrycans.

This volume had to be handled largely in new facilities that the Army brought over and installed in these five months, facilities that are still being increased because this volume of more than 7,000,000 bbls. began at nothing and has jumped every week. From zero on "D" day the imports of gasoline alone, both MT and Av are now averaging 79,570 b/d.

Of this volume an average of 34,000 b/d or 43% moves through the two American pipelines systems but there have been days when as much as 43,300 bbls. have been put through the lines. The remainder, or 45,000 b/d, moves by tank cars of which there is a total carrying capacity of 238,000 bbls. and by tank trucks which have a total capacity of 28,000 bbls.

As a cushion to this transportation system there is now a total storage capacity of 1,500,000 bbls. The extent of the tank building program can be seen from the growth of that storage capacity. At the end of July the total storage then available was 297,000 bbls. most of which had been built during the battle of the beaches. As most of the POL companies were busy laying pipe during the summer and early Fall the big building of new storage came during the past two months when al-

most a million barrels was built. This was all in bolted tanks of mostly 5,000 and 10,000 bbls. capacity.

The tank construction program is being continued in addition to salvaging of much tankage found at refineries and water terminals and bulk plants when the Germans left.

Some of the biggest tankage capacity in Europe is at the ports of leHavre and Antwerp. So when these tanks that can be salvaged are made available, and they are coming into service right along now, the storage capacity for petroleum for the American forces will be greatly increased so that a far greater cushion against anticipated demand will be available.

There is now plenty of sea-carrying capacity, both deep sea tankers and coastal tankers, to more than fill all storage that can be put in shape. There was a time when the tanker supply lines to England and even to the Continent had trouble keeping up with current demand but that is not true now.

97% of Supply Decanted Into Jerrycans Near Front

With the army and navy so steadily and strikingly building up their stocks of gasolines and oils, the POL men here have every confidence in their ability to meet every demand that the military forces can possibly make on them. Besides the petroleum carried as stocks there is a backlog that could be used by draining the pipelines of their fillage which amounts to 150,000 bbls. alone.

Of the bulk stocks of MT fuel brought to the Continent 97% of it is decanted mostly into the 5 gal. Jerrycans before it gets to the front though at times it is possible to make deliveries direct to fighting vehicles from the tanks of tank trucks. The almost universal procedure, however, is to fill the Jerrycans as close to the front as circumstances will permit and then run them forward in small trucks and place them in dumps—long rows—alongside the roads or in handy fields to which the fighting equipment returns for fuel. Trucks pick up their fuel from similar dumps but not ones that are right back of the fighting line. The Quartermaster runs the decanting. He has his own POL companies that take the gasoline from the Transportation department, rail or tank car, which in turn gets it from the Engineers who operate the main bulk supply points.

The number of Jerrycans over here can only be guessed at because every vehicle that has come over carried one or more cans filled. While records were kept, of course, in the excitement of the invasion men on the vehicles were not particular as to how they got enough cans of fuel just so they got them. At all events the records show that at least 13,000,000 cans have been imported by the U. S. Army to the Continent. At 4½ gals. each these cans represent a possible floating storage of 58,000,000 gals. or almost 1,500,000 bbls.

However, not all these cans are in the possession of the army as the native population has found them quite convenient even for handling water. Many more millions of cans are being sent over regardless of their wastage as they have been found to be the most effective means of fueling many hundreds of thousands of vehicles scattered over many hundreds of square miles of territory and most of which are constantly on the move.

The problems of the Jerrycan are those of the oil men in the various services that fill and use them. The staff oil men decide on their number while the services oil men provide the gasoline at the decanting points and see to their being filled. Decanting points are moved about the country as consumption requires but always the aim is to put them at the furthest point to which bulk gasoline can be transported by pipeline, tank car or tank truck so that the haul of the filled and empty cans will be the shortest.

There is one large decanting point near the end of one of the pipelines where as many as 1,250,000 gals. have been decanted in a single day. The POL men say they can handle better than 2,000,000 gals a day if given the cans. This operation had been spread around over several fields but the heavy fall rains made it impossible for the trucks to drive across fields so a place was located near the end of a pipeline where two fairly wide and hard-surfaced roads ran close together and could be shut off from other traffic.

Along these roads were strung pipe with valves and risers far enough apart to permit trucks to unload and load cans. These cans are grouped in lots of 1500 there being 5 rows 100 cans long with each row consisting of 3 lines of cans, one placed on top of the other two. The pressure in the pipeline is reduced so that the cans can be filled by hand through ordinary nozzles with hand shutoff. Tank trucks also load from special risers on other stretches of these roads. The whole operation is so compact that rigid control can be maintained over every truck and everyone on the property.

There are other points where decanting is done direct from tank truck or tank car using either power driven pumps or even hand driven pumps, if demand for filled cans at one point exceeds the supply of pumps there.

Excellent Inland Waterways Being Brought Into Use

Another problem handed first to the planners of SHAEF and Com Z POL and then to the transportation, engineers and quartermaster corps, was how best to use the rivers and canals that network particularly over northeastern France. As this territory was cleared of the enemy, this additional means of transporting petroleum became possible. The questions were to what extent had the Germans left tank barges, in what shape were the locks and if, when the Germans destroyed bridges did the bridges block the channels or could they be cleared away sufficiently for passage of the barges.

Maj. Raymond B. Young, of SHAEF

Oil for the Wheels of the Allied Liberators

Signal Corps Photo

It takes oil to make things run smoothly and the "Wheels" of the invasion forces of the American army must not lack for lubrication. Here, as far as the eye can see, are barrels of oil which will do their part in putting the skids under Hitler & Co.

staff, made special surveys because he was familiar with the inland waterways, having been with the Atlantic Refg. Co. here for years and then with the consolidated American companies as their resident managing director in charge of manufacturing and operations. Particularly he had operated the big Standard Oil refinery at Port Jerome near Havre.

The average American probably little realizes the extent to which France makes use of inland waterways. It is estimated that upwards of 80% of all light petroleum products consumed in France move by her inland waterways and 60% of all such products move by water through the Paris area on the Seine River, a deep and fairly clean stream, with tidal influence a hundred miles back from the entrance to its harbor at leHavre.

Assembling Facts on Inland Water Routes Proved Big Task

Barges by rivers and canals can move from Belgium and Holland through a water network in northeastern France to Nancy, Strasbourg and then through the Marne to the Rhone and down to Marseilles on the Mediterranean. There is also a deep canal that takes coasters across the southwest end of France from Bordeaux on the Atlantic to Marseilles, built primarily as a defense. The Seine up to Paris will take barges drawing 9 feet and above the city barges of 6 feet draft. The large barges will carry 300,000 American gals. and the smaller ones generally 125,000 American gals.

Most of the oil barges are company owned though some are owned even by the skipper. Mostly they are fine looking boats and kept in excellent shape. The skipper and engineer and their families live on the craft, the skipper having quarters at the bow end and the engineer at the stern. If the boat does not have its own power then the stern quarters are occupied by the other member of the crew. Barges without power are towed by tow boats, launches with screws.

From Havre to Paris by direct road is about 150 miles but by river it is nearer 200 miles. In peace times 3 trips a month are ordinarily made and 4 trips from Rouen the practical head of deep water for sea tankers.

In peace times there were 680 tanker barges in operation on all of France's inland waterways and so low was their operating cost that the bulk plants were on rivers and canals rather than on railroads though many barge bulk plants had railroad sidings for out shipment. Of this large fleet of barges the Germans took many back into Germany and others they damaged but there is still a sizeable number left and in fair to good operating condition.

It was the job of the POL men of the staffs to get the facts regarding these barges and inland waterways, find out their present condition and figure out the best way to use them and how much gallonage they could be depended upon to transport. One of the handicaps to their use was the way both our bombers and the retreating Germans had blown up bridges. When they fell, spans generally blocked the channel with the result the engineers have been busy clearing away the wreckage. With the present floods the high water has increased the current and some of the channels narrowed by bridge wreckage had still speedier currents.

But despite the difficulties the oil men have figured out ways to put all the available barges into immediate service and to keep them moving.

Using the inland waterways makes available a large amount of oil storage that can be used for reserve and it also provides such additional transportation, that heretofore has not been available to the Allied Forces as to hasten the day when more petroleum products can be issued to essential civilian use, particularly such as gas oil for artificial gas plants and to run electric light plants.

This is but a quick glimpse of the problems before the oil men of POL. Col. Burford's POL section of Com Z has to not only seek out problems, seek out army needs of oil, but to keep daily checks on its use of all products, the condition of all stocks at all important points, and always to be planning months ahead for the ultimate objective—to have more than enough petroleum at every point where the Army might possibly need it regardless of unforeseen contingencies.

All this is written from a much more intimate knowledge of the POL and oil men over here in their various capacities, than the facts censors will permit being published might indicate. I have spent my whole time with these men day and night, have heard their gripes and disappointments, have listened to their plans, have ridden out on trips with them. From this intimate contact and many are men I have known for a great many years, some even 25 years, I know these men are doing a fine job, one that the industry will be proud of when the whole story can be told, and a job that is going a mighty long way to help win this war with the minimum loss of limb and life.

As these men return home, and they are starting to return now that the period of big planning has past, they should be received with public acclaim by the oil industry everywhere. They have interesting stories to tell and the industry will have a better idea of this war and the price it is costing as well as a better idea of the part oil and oil men are playing in it, if industry organizations will invite these men to tell their story, or such of it as censorship will allow.

And when they do appear before you, give them a hand, yes, stand and give a cheer, for they have done a great job not only for their country but for you and for me.

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Thumbnail Sketches of Men Who Help Burford

Mr. Platt has written the following sketches of members of the POL staff attached to Gen. Eisenhower's headquarters under Col. Freeman W. Burford (see front cover) who is the chief petroleum officer for the Communications Zone of the Army Supply Services:

Maj. James A. Dimock came into the Army as a transportation specialist from the Standard Oil Co. of New Jersey and is using in POL work here in France the same skill and experience he developed with Standard. There he was charting and planning developments in distribution. Over here as Chief of the Supply and Movements Section he is, in effect, doing the same thing, matching the supply of petroleum products against the needs, storage and transportation facilities in order to take care of all needs and get the best service from the facilities.

Maj. Dimock was born in Wakefield, Mass., but the other night he could not remember the name of the town and another resident of his own state had to figure it out for him. The major says that a few years of war makes you forget most anything except what is going on at the moment. He graduated from Columbia University in 1931 and at once went to work for "the Jersey Co".

He also joined the officers reserve corps so when in June, 1941, a friend wanted him in a certain army job, he answered the call as a second lieutenant. After three years in the supply services, mostly at Savannah, Ga., he was transferred to London in April of this year and went to France in "the Forward Echelon", landing July 11. This outfit became the present POL Section of COM Z.

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Maj. Harley J. Holcomb is a refinery chemist and engineer, who started his service in the oil industry at Skelly Oil Co.'s refinery at El Dorado, Kans., where he was in charge of the lubricating laboratory. In 1928 he went with the old White Eagle Refining Co. as chief chemist at their Casper, Wyo., plant. After Socony-Vac took over White Eagle, he became foreman of their Houdry unit.

Major Holcomb joined up early—in 1941. (*See NPN, Oct. 11, 1944, p. 6*). For two years he was in the Air Corps, and in '43 was transferred to the Intelligence Section and sent to Washington. He was then transferred to the Fuels and Lubricants Division as Chief of the Inspection Section. He has had much to do with the development of Army oil testing, particularly its mobile testing laboratories.

He organized various inspection and laboratory units in the U. S., including five field offices and a training school.

Key Men of POL Keep Vital Oil Supplies Moving

1—Lieut. Col. Howard C. Pyle
2—Maj. James A. Dimock
3—Maj. Harley J. Holcomb
4—Capt. Oliver A. Bakhaus
5—Capt. H. M. Borden
6—Capt. H. D. Burnham

All told, seven such units were activated.

At present, Maj. Holcomb is chief of the Technical Section with POL, supervising the technical and testing work. He came to England last March in the special party of oil men headed by Col. W. C. Pew, of SHAEF staff, and was early on the continent.

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Capt. Oliver A. Bakhaus is an Independent Kentucky jobber who joined the army and then sold most of his businesses. Now he is in France as chief of Distribution and Plans of POL for COM Z.

It has long been suspected that "Kentuckians" come from most everywhere. Capt. Bakhaus confirms the suspicion. He was born in Oklahoma, at Okema near where his father had a ranch. They moved to Oklahoma City when that town started to boom and another hardware store seemed to be needed.

Capt. Bakhaus graduated from the University of Oklahoma in 1929 in business administration. With his brother he bought a citrus ranch down in "the valley" at McAllen, Tex., in 1930. But the citrus business was greatly languishing, so to ease the pressure Capt. Bakhaus took a commission agency with the old Indian Refining Co. from an old Oklahoma friend, C. L. Thomas, whom the Texas Co. had transferred to Kentucky when it bought the Indian. The agency was at Covington, Ky., so Oliver became a Kentuckian and later was duly anointed, along with 100,000 others, a "Kentucky Colonel" by Governor Chandler.

In 1943, he and D. J. Burke, a Texas Co. salesman, started the Kentucky Independent Oil Co., a name which the Shell had dropped after buying it from the late E. H. Hilpp of Louisville, only the new company was started at Lexington.

Capt. Bakhaus retained his Indian agency at Covington until 1937 because the new company was starting very much from scratch. It did not have a single customer when the first car of gasoline arrived in Lexington. After they rustled about town the man who did some laundry for them finally bought 250 gals.

He is so proud of being the first customer of what became one of the several largest Independents in Kentucky that he has his check in payment of that purchase hung in a frame in his office today.

The company grew rapidly and put in bulk plants also at Winchester, Paris, Maysville, Cynthiana and Versailles, Ky. Its gallonage was hitting 7,000,000 a year. In December of 1942 the company sold to Aetna Refining Co. of Louisville, whereupon Messrs. Bakhaus and D. J. Burke, his partner, formed a new partnership with a third member and took back three of the bulk plants, at Lexington, Paris and Winchester on a commission basis. They operate as Mahan, Bakhaus and Burke. Then the second member of the firm decided to go to war.

He had been president of the Kentucky Independent Petroleum Marketers Assn. and when his intention of joining the Army was announced the association insisted on re-electing him though he left right away.

He was commissioned as a captain in the Ordnance Dept., because of his knowledge of the oil business. He was sent to various arsenals but never once had anything to do with oil until he was transferred to London with the POL group last spring. He was the second on the Continent of the Forward Echelon Group, now POL for COM Z.

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Capt. H. M. Borden was a refinery process engineer with the Tide Water Oil Corp. and in France he is chief of the Supply & Movements Section of POL at COM Z Hq. He was born at

Independent Jobber Is Executive Officer on POL Staff

Capt. Arnold E. Dubb . . . he's in on all the 'secrets'

PARIS—There are a number of Independent oil jobbers in France and elsewhere in war centers, doing important work for the war and Capt. Arnold E. Dubb, of Schenectady, N. Y., is no exception. He is the executive officer of Col. Burford's POL headquarters staff.

The business of the office comes and goes across his desk and he has to see that it keeps moving, that generals get what they ask for as well as that they find what is generally on the generals' desks before they think to ask for it.

To keep the machinery running smoothly he has to, and does, know all the "secrets" of things that are doing way "up front," back in the base sections and what is coming in from the U. S.

Capt. Dubb's 10 years administering of a large Independent oil business, dealing in both fuel and gasoline, fits him into this job exactly. His oil company is the Port Petroleum Corp. It now owns a bulk plant at Schenectady and another at Green Island, near Albany. The company had a string of service stations but some have been closed down and others sold since the captain came into the Army and he has lost track of their number, just as most oil men over here have lost recollection of details of their businesses back home.

Capt. Dubb went into the oil business with his father when he was graduated in economics from Union College, Schenectady. The business had been established by his father in 1920. When Capt. Dubb finished college in 1932 the business was reorganized under its present name. The captain became its secretary and treasurer and the business was pushed ahead so that it became one of the larger Independents in the state.

In 1942 Capt. Dubb enlisted as a private and then took the officers' training course and got a second lieutenancy. After serving in the U. S. he was assigned to the Area Petroleum Office in London in October 1943. He soon became its executive officer where Col. Burford found him and took him into the POL branch for COM Z which Col. Burford organized on the continent last August.

He was then Lieut. Dubb but after he came to the continent in August he was promoted to a captaincy. As the "POL Hq" moved from Cherbourg to "the woods" and then on into Paris, Capt. Dubb followed the routine of his associates, through tents and mud and open door messes to the unheated offices and sleeping rooms of once "Gay Paree" as the supplying of petroleum became an ever increasing job and had to be managed nearer and nearer the fighting forces.—WCP.

Taunton, Mass. (he was the Yankee who finally got Maj. Dimock's recollection refreshed as to where the latter was born in Massachusetts.)

Capt. Borden went to "MIT" at Cambridge, Mass., and got his BS in 1936 and his MS the next year, both in chemistry. He then went to Bayonne and was process engineer in the development lab of Tide Water until he went to Arthur D. Little, Inc., at Boston in 1940.

Two years later, as a member of the Officers Reserve he went into the Army in Ordnance and worked at some of their chemical establishments until he was transferred to London as part of the oil group that went there this spring. He was in the Area Petroleum Office until October when he was transferred to POL at COM Z Hq.

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H. D. Burnham is a new captain but also he is a "PH D" in chemistry. He got that degree at Princeton in 1940 after getting his "BS" in chemistry at the University of California in 1937. He was born at Berkeley, Calif. He worked in the research laboratory of Shell at Wood River, Ill., for two years when he joined the army.

After working in the ballistics laboratory of the Army at Aberdeen Proving Ground he was picked to go with the group of oil men to London this last spring. From there he went to France in July and he is now in the Supply and Movements Section of POL COM Z. Last week he got his captaincy.

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Lieut. Col. Howard C. Pyle, for five years chief production engineer for the Union Oil Co. of California at Los Angeles, is chief deputy to Col. Burford.

Col. Pyle has had much experience in war planning for oil. He volunteered for the Army early in 1943. For six months he was in the chief engineer's office at Washington and was then transferred to the new Fuels and Lubricants Section of the Quartermaster's Department, then being reorganized by Gen. Covell.

Here he became chief of the Development and Rehabilitation Section that was charged with the task of rebuilding oil properties in the Dutch East Indies as soon as the Japanese could be driven out, and also with assembling the surveys on oil storages in the rest of the world to make the data available as soon as they should be needed. The Far East proposition was finally dropped as impracticable.

Col. Pyle came to England last January as a major and was the American POL officer on the staff of Gen. Montgomery when he had full charge. When responsibilities were divided and Gen. Eisenhower headed up SHAEF, Col. Pyle continued with SHAEF and in October this year moved over as Col. Burford's chief assistant in POL for COM Z in Services of Supply.

Col. Pyle was made a lieutenant colonel this October.

He has degrees in engineering, petroleum engineering and mining engineer-

The ranking officer of this office group is the shorter gentleman on the right, Corp. Albert B. Stanger of St. Louis. The next in rank is the gal with the smile Miss Margaret Steger as she is a Technician 4th Grade while the "high private in the rear rank" is the lowliest, just an enlisted man though he is studying to be a "PHD", is boning up on things out at the famous French University at "The Sorbonne" and has taught various military possibilities in schools back home. He is Joel B. Dirlam, from New Haven but his dad and forebears lived in Mansfield, Ohio, this correspondent's home for a number of years and he knew the Dirlam family well.—WCP

ing from the University of California from which he graduated in 1926 and from the University of Southern California. He has worked for the Union Oil since leaving school, in this country, South America and Canada. He made a Survey of the Canol Project in Canada and covered 10,000 miles by plane in doing it.

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Here's List of Others On Col. Burford's Staff

Other members of Col. Burford's staff in POL Group G-4 are: Normandy Base Section—**Lieut. Col. Earl R. Chase** of the Magnolia Petroleum Co., Dallas; **Capt. H. A. Schramm**, lubricating engineer; **Capt. F. H. Blunck**, Standard of Indiana refinery engineer, Whiting, Ind.; **Lieut. A. L. Hirlinger**, refinery engineer and tanker service.

Brittany Base Section—**Lieut. Col. H. W. Matthews**, petroleum engineer.

Oise Section—**Lieut. Col. E. A. Bacon**, crude oil buyer for Shell Oil.

Channel Base Section—**Capt. C. O. Bennett**, refinery engineer; **Lieut. H. T. Hoover**, technical engineer; **Lieut. E. T. Marsh**, petroleum engineer.

Seine Section—**Lieut. Col. Albert Finston**, refiner and producer, Tulsa.

Advance Section—**Capt. W. C. Myers**, oil distributor, and **Capt. L. H. Conklin**, chemical engineer and paints, Newark, N. J.—WCP.

Corp. J. T. Fryer, (above) who presides at the chief clerk's desk in COM Z, POL, was born and raised in the middle of a fine lot of oil derricks at Frederick, Okla., but none of them ever rested on his father's farm nor did the corporal ever work in the industry. He says he has looked at it fondly but this job here is his most intimate contact with it. He was getting out of high school when the draft picked him up and fate gave him this oil job. Now when he gets back, he may try to be an oil man, as he rather likes the schooling he has had in it over here. So do the men who have worked with him, like their student

Pennsylvanians Nail Pearson On Russianized Oil Wells

NPN News Bureau

CLEVELAND — Columnist Drew Pearson drew a quick reply from the Pennsylvania Grade Crude Oil Assn., following the publication of an article by him in the current issue of *Cosmopolitan*.

Predicting things to come in 1945, Mr. Pearson said: "We shall actually import oil from Russia and store it in the depleted, non-porous oil wells of Pennsylvania."

Replying to this, the association pointed out that there were billions of barrels of top quality crude oil still in the sands of the Pennsylvania Grade region. The association said it would be folly to import Russian oil and try to store it underground there.

Terming the project "utterly unrealistic", the association said that the economic factors involved in any project to bring in Russian oil and force it under pressure into the Pennsylvania sands, only later to recapture the same crude by expensive secondary recovery, would involve costs exceeding greatly the present price of Pennsylvania Grade crude at the well.

Far from being depleted, the Association said, Pennsylvania Grade crude oil sands contain 6,364,021,000 barrels of premium petroleum. Recoverable by present methods are 927,856,000 barrels, equivalent to a 34-year supply at today's rate of production for this area.

But most serious to the nation, the Pennsylvania oil industry's spokesman said, would be the inevitable contamination of the Pennsylvania Grade crude by the cheap Russian oil, precluding the recovery intact of the Pennsylvania oil, and leading to unavoidable loss of petroleum deposits on which, conservatively, one-fourth of U. S. motorists depend for car lubrication in normal times, and on which the government now relies heavily for aviation lubricants and other special oil products for the war machine.

Secretary at Supply and Movements section of the POL COM Z office is Miss Alice M. Murray (below). She has had no oil company experience, having enlisted as a WAC in the early days of the war and was assigned to this work in COM Z.

PIPELINES—*Views of the Industry's Problems*

Washington— *New Congress Must Settle Many Important Oil Matters* —By Herbert Yocom

WASHINGTON—Many matters of paramount importance to the oil industry will come before the 79th Congress, which convenes this day.

First and foremost, to the new Congress will fall a large part of the responsibility for shaping the policies that are to govern worldwide petroleum operations in the years to come.

Mr. Yocom

The recent Congress made at least that much certain by doing to death the administration-sponsored Anglo-American oil agreement after it had aroused the almost 100 per cent opposition of the domestic industry. As a result, the administration is now reconciled to the fact that not only Capitol Hill, but also the industry, will have to be harkened to in all future efforts to conclude a treaty with the British.

Just in case, however, no less than three congressional committees will be on guard to make positive that nothing slips by—the Senate committee on foreign relations, chairmaned by Texas' Tom Connally, the Special Senate committee on national oil policy, which is due to be reconstituted before the month is out, and the Lea oil subcommittee of the House, which likewise is to be reestablished.

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Almost certain to be raised as an issue, when Congress gets aroud to considering tax legislation, is the old question of the percentage depletion allowance. Treasury Secretary Morgenthau got batted down by the House Ways and Means committee when he sought removal of the provision from the law a couple of years back, but the expectation in industry circles here is that he will be back again this year to renew the request.

The general belief is that his chances for success are as poor now as they were then.

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Another matter that will move rapidly to the fore involves the extent to which government shall participate, postwar, in the financing of scientific research. It will be pushed there by the Senate Kilgore committee, which in the past has come forward with ideas that have raised fears in industry quarters that new deal thinking is trending in the direction of complete government control of all research activity.

A report to be filed with the Senate next week should throw new light on this subject. Extensive hearings also are planned for late January or early February.

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It's doubtful at this early date, whether the new Congress ever will get around to voting on the question of a general price increase on crude oil, although the matter is one that will come in for extensive discussion and may even be made the subject of committee hearings. A lot depends, in the end, on the investigation now being undertaken by OPA, but even if the OPA study results as expected in another turn-down the chances of forcing a test in either branch of Congress would seem extremely problematical.

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Of Oil Interest in the Capitol

Successor to Oklahoma's Wesley Disney on the House Ways and Means committee is Rep. Anderson, of New Mexico . . . Sen. Maloney, of Connecticut, wants the senate to authorize continuance of the special committee created back in 1941 to investigate fuel shortages. He thinks the committee can serve a worthwhile purpose, if only for the reason that it can keep the public up-to-date on developments in the supply situation . . . one investigating committee slated to

(*Continued on p.* 13)

Atlantic Coast— *Industry Concerned About Government's Tanker Progrc*—By Frank P. S. Glassey

NEW YORK—Has the U. S. Maritime Commission made its first serious mistake since Pearl Harbor by placing another contract for 20 deep-draft tankers to be built during the last six months of 1945?

Mr. Glassey

When War Mobilizer James F. Byrnes last week approved a 1945 program for construction of 186 new tankers, Victory and Liberty ships for delivery in the latter half of the year, he, in effect, endorsed a policy which leaves some oil men wondering whether the tankers will be easily adaptable to industrial purposes once the war is won. The 20 tankers included in the plan will all be of the T-2 and T-3 types, ranging in capacity from 135,000 barrels. These ships are of 32-foot draft.

For military purposes, particularly in transporting petroleum products to the European theater, the T-2 ships are ideal. When the war is over, however, they will not meet with much favor from the oil industry, since many terminals lie on shallow water where a tanker of 32-feet draft could not enter. The industry wants fast, smaller tankers of 27 to 28 feet draft. Obviously that is not what the industry is going to get.

At the year-end, the U. S. tanker construction program for 1945 comprises 262 ships, of which 173 have been authorized for the first six months and 89 in the next six months. The 173 include 130 T-2 and T-3 types; six for private operators, most of the T-2 type, and 37 of the smaller, or T-1 type, with a capacity of 125,000 barrels.

A total of 463 tankers have been produced in U. S. shipyards during the last two years, with recent production averaging 20 monthly. Four yards are handling most of the construction: Henry J. Kaiser at Swan Island, Portland, Ore.; Alabama Drydock, at Mobile, Ala.; Sun Shipbuilding, at Chester, Pa., and Marine Shipbuilding Corp. at Sausalito, Cal.

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Sponsorship of an art program by an American industrial corporation is nothing new. American Tobacco Co. did it as part of its advertising campaign on Lucky Strikes. But, so far as this writer is aware, the idea has never before been tried on a large scale by a major oil company.

Now Standard Oil Co. (N.J.) reveals that it is commissioning a number of the nation's foremost artists to do a series of oil paintings which will reflect all phases of the petroleum industry. Some months ago, Jersey Standard launched a preliminary project when it financed several artists, including Adolf Dehn and Reginald Marsh, to do watercolors picturing the oil industry at war. These watercolors were shown at the Brooklyn Museum.

Current plans, however, are far more ambitious. Jersey has already commissioned seven leading artists, of whom five have finished preliminary work on oil paintings. The other two are now on location. The company also is commissioning artists, who are now overseas for other organizations, to do special paintings of oil at war.

Here's the line-up of Jersey Standard's artist team at present:

Thomas Benton is painting the Mississippi barge line, the Choctaw fields and Baton Rouge operations.

Ernest Fiene is concentrating on toluene, mainly at Baytown and at Baton Rouge.

Reflected by NPN Writers at Three Vital Points

Joe Jones is covering the Western oil fields and the Gulf basin.

Frederick Taubes will do pipe lines.

Francis Criss has been assigned to the Esso laboratories.

Adolf Dehn is now in Venezuela, depicting Creole Petroleum's operations there.

Georges Schreiber is painting at Norman Wells, Alaska.

"We initiated this plan because of its vast possibilities in dramatizing the oil industry story," a Jersey Standard spokesman said. "Fine arts is a valid form of reporting, and has been so regarded ever since the days of the Pharaohs."

Esso's artists are being given much leeway in their choice of subjects and manner of presentation. When the collection is completed the paintings will go into a permanent company exhibition. First, however, they will be shown throughout the country in museums, schools and other public institutions.

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Officials of three major rubber companies issued year-end statements here stressing the importance of the synthetic product. Goodyear, Goodrich and Firestone seem convinced that synthetic is here to stay and will play some part in post-war industry.

John W. Thomas, chairman of Firestone Tire & Rubber Co., said that synthetic faces its greatest task in the immediate future, and asserted that new techniques promise greater production and a tougher tire. He pointed out that whereas 65 per cent of the rubber used in 1943 was natural, in 1944 the percentage was reversed in favor of the synthetic product.

Synthetic has still not reached the point where it can compete with natural rubber, once conditions return to normal, John L. Collyer, president of B. F. Goodrich Co., said. He added, however, that at least progress has been made to assure manufacturers that the price of natural rubber will have to be kept at a reasonable level to meet the threat that synthetic rubber offers.

Meanwhile, uses to which synthetic rubber can be put are being extended, Herman R. Thies, plastics expert for the Goodyear Tire & Rubber Co., said, announcing that discoveries have made it possible to use the synthetic product in making goods formerly made only of natural rubber. He said that the new compounding ingredient will have no effect on tires but will make far more natural rubber available for that type of manufacturing.

Midwest— *Streamlining Advisory Committees Would Help OPA-Industry Relations* —By Earl Lamm

CHICAGO — Help and co-operation of the oil industry with OPA will gain on a wide-spread scale in the marketing branch of the industry as representatives of OPA, particularly in Washington, by their acts establish their sincerity and desire for such help. It will take more than just OPA threats or promises and it seems to us that the two recent revisions in the dealer bail-out program represent quite an improvement in OPA's attitude.

Mr. Lamm

As yet, however, OPA has not found the full solution to the honest dealer's difficulties, but it is hoped by the distributors and marketers with whom we have discussed the problem since the amendments came out that OPA will continue its efforts.

When some plan is made effective whereby dealers who behave themselves can see the light of day beyond their debits they will be much encouraged to work out from under the load.

While bail-out amendments 163 and 168 appear helpful, most jobbers who have grown cautious about OPA, hesitate to commit themselves for the amendment has not yet been fully understood and tested by the trade. This and other OPA-industry problems can be considerably helped by streamlining the advisory committees, Joseph Hadley, secretary of Michigan Petroleum Assn. has pointed out. The advisory committees as now set up are doing good work when given the opportunity by OPA, but in most instances their meetings are too irregular, uncertain and disconnected with no channeled flow of information, such as prevails in the PAW-industry set up.

For instance, when the various OPA district advisory committees meet and arrive at some conclusions, they have no uniform way of passing their individual committee conclusions on to the national advisory committee to form a general consensus and follow up by the national committee at Washington.

Mr. Hadley suggests that a man from each OPA district committee be formed into a regional committee and that a member of each OPA regional committee compose the national advisory committee. Thus, information or solutions to problems as they arise could flow smoothly in either direction, to or from the industry, through industry men who have first-hand experience with the current situation.

* * *

Further investigation of the idea for use of input meters at bulk plants as previously mentioned in this column (*NPN Dec. 13, p. 13*) indicates its practicability, especially if a few changes are made in some bulk plant piping hook ups. Two manufacturers of meters tell us that meters they now make will take care of input as well as delivery of products, and that the meters will pay for themselves in nine months to a year at the average bulk plant by elimination of time and a half wages for a night man at the plant.

The manufacture of meters has been slowed down by the war, but in the present critical transport shortage—including the shortage of tires—plus the difficulty of obtaining sufficient manpower, perhaps the necessary material for manufacture of the meters would be allocated by WPB if the need is clearly explained.

* * *

Reflection of industry opinion in the Midwest is that the increase of Ethyl gasoline available for civilians from 25% to 37.50% authorized by PAW last week, will not make much difference in the muddled market situation. The change brought only a sigh from the industry, and a prediction by some unfortunates whose supply is very short that they will continue to lose business. They charge that certain large companies who apparently have plenty of Ethyl are taking their accounts, and that one or two other majors are cutting their own outlets in some districts 5% in order to accumulate enough Ethyl to solicit new business.

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First draft of PAW Distribution and Marketing Director Walter Hochuli's big book of instructions on how to operate a service station, which is being compiled for the Department of Commerce upon request of the Army, is now being circulated among marketing committee members and a limited number of others for checking and editing. The mimeographed copy, with most sheets double spaced typewriting, is over 400 pages thick, and covers the subject from A to Z. It was written by, and is being edited by experienced industry men and when completed doubtless will be of great help in training military personnel returning to civilian life via small business. It is understood that similar books pertaining to small business of other industries also are being prepared.

Since the completed service station book probably will represent the consensus of many thoroughly experienced industry men, service station operators everywhere can read it with profit.

Army Consumption of Gasoline in U. S. Running Only 10 Gal. per Month per Man, Report Shows

NPN News Bureau

WASHINGTON — During the six-month period April to September, 1944, the Army in this country used only 31,820 barrels of gasoline daily, according to figures released by the Quartermaster General's office. This is equivalent to 10 gallons per month for every soldier then on duty in the United States. Of this, only 2680 b/d consisted of 80-octane gasoline, 29,140 b/d was other gasoline.

This is the total gasoline (excluding that used for Army Air Forces' aircraft) for all Army purposes, including the training of troops, the moving of supplies, the repairing and maintaining of Army facilities, and the operating of depots, ports, and government manufacturing plants.

The Army gasoline requirement in the United States represents about 2.5% of the total motor gasoline allocated for civilian use. Although no direct comparison with civilian consumption can be made on a per man basis, the public relations branch of the War Department points out, some interesting comparisons may be made, by comparing the present "A" gasoline ration to civilians—8 gallons per vehicle per month, without considering the additional gasoline allowed for essential business driving and for the operation of trucks, busses, and non-automotive uses—with the Army consumption figures.

Total Figure 72,420 b/d

Total petroleum consumption (excluding aviation products) by the Army in the United States averaged 72,420 b/d during the six-month period, according to figures released by the Fuels and Lubricants Division, Office of the Quartermaster General. Consumption figures for the Army in overseas theatres of war cannot be released because of security restrictions.

The summary figures show that the Army, in this country, used the following quantities:

	Army Consumption Continental U.S. 6 Mos. April—Sept. 1944 (barrels daily)
80 Octane Gasoline	2,680
Other Gasoline	29,140
Kerosine & Solvents	1,430
Diesel Fuel Oil	3,040
Other Distillate Fuel Oils	6,780
Residual Fuel Oils	25,810
Lube Oils & Greases	1,790
Asphalts	1,270
All Other Products	480
Total Products	72,420

The above rates of consumption are not expected to change materially during the remainder of this year except for increases in fuel oils for heating purposes. The seasonal increase in fuel oils may raise the distillate consumption rate to about 17,500 barrels daily and the residual consumption to about 35,100 barrels per day during the winter months.

The Fuels and Lubricants Division of the Office of the Quartermaster General, has a system under which every post, camp, station, port, depot, manufacturing plant, construction project, or other activity under the control of the Army in the Continental United States prepares a monthly report of petroleum products used and held in storage. These reports are examined by the Fuels and Lubricants Division, to insure that critical products are being properly used and that stocks are not being built up or maintained at excessive levels, a report from the War Department states.

The reports are then tabulated and the summary figures are analyzed by type of use by geographical distribution in order that long-term plans as well as procedures for allocation and procurement may be developed on a sound basis.

80-Octane Control Strict

The consumption of 80-octane gasoline —the premium, all-purpose fuel developed for combat use—has averaged only 2,680 barrels per day in this country during the six-month period. This is the result of strict control over the use of this product which is allowed only for tactical equipment and in cases where training schedules demand simulation of battle conditions.

The Army's consumption of Diesel and other distillate fuel oils in the continental United States is equivalent to about 3% of the total of these products allocated for civilian use.

Of the total fuel oils 5,980 barrels daily of distillate fuel and 5,140 barrels of residual fuel were used for heating and power plants during the six-month period. The remainder is required for the operation of Army transports, harbor craft, rail equipment, and construction facilities.

The total consumption of petroleum products by the Army in the United States (72,420 barrels daily) represents about 1.5 per cent of the nation's present output of crude petroleum natural gasoline, and benzol.

Stock levels have been subject to increasingly careful review by the various Technical Services and the Service Command Headquarters, and effective methods of control and redistribution have been established in coordination with the Fuels and Lubricants Division, OQMG. Product standardization and the revision of specifications have resulted in some accumulation of excess stocks at certain installations, particularly in the case of greases. Such excesses are being liquidated by control of purchase and by the transfer of these stocks where possible to other points within and outside the country.

18-Day Average Supply

Army-owned stocks of products not including stocks for theaters of war, but only for use within the continental United States on Sept. 30, 1944, were at the following levels based on the consumption rates during the preceding six months:

	Stock Level in Terms of Days of Supply September 30, 1944 (days)
80-Octane Gasoline	17
Other Gasoline	10
Kerosine & Solvents	20
Diesel Fuel Oil	19
Other Distillate Fuel Oils	25
Residual Fuel Oils	20
Lube Oils & Greases	51
Average All Products	18

As pointed out above, aviation products and overseas requirements are not covered by the foregoing figures. The

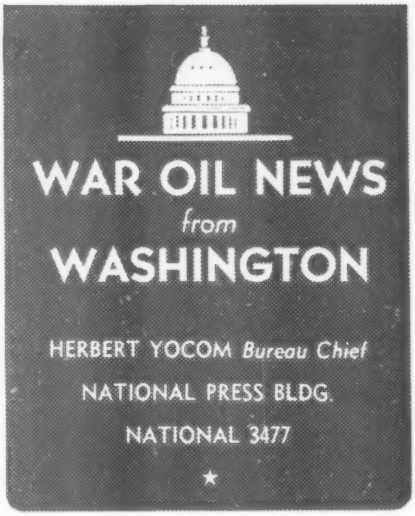
U. S. 'Gas' Tax Take Rises As Agencies Kick In

NPN News Bureau

WASHINGTON — Federal gasoline tax receipts of $33,114,838.30 in November, 1944, were more than $9,000,000 higher than those of November, 1943, and lubricating oil taxes totaled $6,750,243.85, more than $3,000,000 above November, 1943, the Bureau of Internal Revenue announced this week.

Increases were explained by Bureau and Treasury officials by the fact that under terms of Sec. 307 of the Internal Revenue Act of 1943, federal agencies have been prohibited from claiming tax exemptions when making purchases or items subject to manufacturer's or retailers' excise tax, with exception of cartridges, radio and other specified war material. Accordingly, War and Navy departments have notified their field offices not to claim exemptions in purchase of lubricating oil or gasoline, except in making purchases under terms of "old contracts"—those signed prior to June 1, 1944—or under extensions of those "old contracts."

Tires, inner tubes, and other rubber articles—like petroleum products—are now, in most instances also subject to excise taxes when sold to federal agencies.



relatively small use by the Army in this country should not be misinterpreted, therefore, since the additional Army demands for aircraft and for overseas as well as the Navy demands and those of our Allies greatly exceed those shown herein. However, the above figures on Army consumption and stocks in the continental United States are being furnished to the petroleum industry and the general public to contribute toward a better understanding of the part that Army operations in this country play in the over-all petroleum supply and demand picture. The Army is vitally concerned in making every effort to avoid waste and obtain the maximum use of one of the most important of our natural resources.

Page Takes Coleman Post As PAW Program Director

NPN News Bureau

WASHINGTON — Stewart Coleman has resigned as director of the PAW program division, and has been succeeded by Howard W. Page, who moves up to command from the post of assistant director.

Simultaneously, Jerry A. Cogan becomes the associate division director instead of assistant. As such, he will direct program activities for foreign supply, while Page will concentrate on domestic supply and administrative matters.

Mr. Coleman, who is returning to Standard of New Jersey, was the first director of the program division. Both his successor and Mr. Cogan came to PAW from the same company.

Petroleum Stocks Increase Half-Million for Week

NPN News Bureau

WASHINGTON — Domestic and foreign crude petroleum stocks for the week ended Dec. 23 totaled 222,575,000 bbls., up 500,000 bbls. from preceding week, the Bureau of Mines announced this week.

There was an increase of 635,000 bbls. in stocks of domestic crude and a decrease of 135,000 bbls. in stocks of foreign crude. Heavy crude oil stocks in California totaled 6,456,000 bbls., down 72,000 bbls.

Current reports of the industry for the week indicate an increase in crude oil production to 4,729,000 b/d, or 33,000 b/d above preceding week. Daily average crude runs-to-stills totaled 4,682,000 b/d, up 145,000 b/d from the previous week and 478,000 b/d above week ended Dec. 25, 1943.

Major increases were Oklahoma, up 455,000 bbls.; New Mexico, up 204,000 bbls.; Texas, up 188,000 bbls.; Kansas, up 184,000 bbls.

Major decreases were California, down 436,000 bbls.; foreign, down 135,000 bbls.

Blazer Joins Bank Board

NPN News Bureau

WASHINGTON—Naming of Paul G. Blazer, board chairman of Ashland Oil & Refining Co., as a director of the Cincinnati branch of the Federal Reserve Bank of Cleveland, was announced this week.

Industry Advisory Committee Is Named by OPA To Present Final Facts on Crude Price Rise

(*Continued from p. 3*)

prices of crude oil are adequate or an industry-wide increase is needed."

Mr. Bowles said:

"This does not represent any change in OPA's position, stated many times, that, in its opinion, there should be no general price increase for the crude oil industry as a whole. We are glad to make the survey in response to congressional committee and industry requests for a cost study. This will give us additional data for determining whether OPA's stand against a price increase is justified.

Committee First Step

"One of the first steps leading to the survey will be the appointment, shortly, of a National Crude Oil Industry Advisory Committee, composed principally of non-integrated or independent producers and containing representatives from major oil companies. The appointment of such a committee was also recommended by the House committee on Small Business and the Industry.

"The new committee will be called upon to assist OPA in making the cost survey, and will continue in existence as a national body representative of crude oil producers with which OPA can consult on matters of an industry-wide nature. This committee is in addition to industry advisory committees for the crude oil industry already in existence for different areas of the country.

"One of the first actions to be taken by the new national advisory committee, when it is appointed, will be to help OPA in deciding what information should be sought from a representative segment of producers in connection with the cost survey, which will show their financial position under the existing ceiling prices."

Mr. Bowles also announced that he would later appoint a national industry advisory committee representing the refining branch and take up with it the House Small Business Committee's recommendation that a study be made of refiners' operating costs "to determine the ability of the refiners to absorb any general price increase to producers if any may be shown to be required by the survey of producers' costs."

The Patman Small Business Committee, Mr. Bowles pointed out, suggested that, in order to prevent price increase in oil products to consumers, OPA should grant a subsidy to marginal cost refiners whose profits might be adversely affected by any further increase in the ceiling price of crude. He said this question would be taken up with the committee when it is appointed.

Explains 'Adjustments'

Mr. Bowles' statment also dealt with individual price increases already granted, and the stripper-well subsidy program and "high-cost" relief programs recently put into effect. On these points, he said:

"While OPA has not favored a general price increase for crude oil, it has granted individual adjustments in producers' ceiling prices from time to time. These adjustments have been allowed where existing ceilings have caused hardship or where prices have been shown to be below those for comparable crudes in the same general area. None of these increases is passed on to consumers in the form of higher prices for petroleum products.

"OPA's stand against a general price increase has been based on the three main points: That it would be contrary to the President's 'hold the line' policy; that it would raise the prices of petroleum products to consumers, and that such an increase is not justified by the earnings position of the industry.

"In addition to individual adjustments, increases have been granted since Aug. 1, 1944, to stripper pools. Under a premium payment plan, first purchasers of the oil from qualifying stripper pools are reimbursed by the government for the increased amounts paid. In this way higher prices for petroleum products have not resulted. The increases range from 20 to 75c a barrel.

"OPA also announced on Oct. 31, 1944, that crude oil pools other than those eligible under the nine-barrel provision of the stripper plan may apply for increased ceilings where they can show that average production costs for a pool are above the ceiling price for that pool. A maximum increase of 35c a barrel is permitted for pools that qualify under this extension of the premium payment plan for stripper pools. Many applications already have been received and are now being considered."

ICC Extends Order Relaxing Rules on Tank Truck Use

WASHINGTON—With manpower and material problems continuing to prevent petroleum transporters from repairing all their oil tank trucks, ICC has again extended its order of Dec. 31, 1943, which relaxes restrictions on the use of tank trucks which were in operation before June 15, 1943. Order originally was slated to expire Dec. 31, 1944, but has now been extended through 1945 by order of the commission.

Unless V-E Day comes before Dec. 31, 1945, the new date of expiration set for the ICC order, it may prove necessary to extend the order through 1946, one ICC spokesman said, as there is little relief in sight on either manpower or materials needed for tank truck repair.

ICC's action, effective on and after Dec. 31, 1944, was taken in Part 197 —transportation of explosives and other dangerous articles—(9 F. R. 540).

High Praise Given U. S. Oil Industry and PAW In Final Lea Committee Report to Congress

NPN News Bureau

WASHINGTON—The House Interstate and Foreign Commerce Subcommittee on Petroleum, headed by Rep. Lea of California, this week filed a 10,000-word report with Congress in which it reiterated, but less strenuously than heretofore, the necessity for action on crude prices.

The committee also called for support of OPA in the fight against the gasoline black market, and paid rare tribute to the "genius and productive capacity" of the American oil industry and the excellent administration of war-oil regulations by PAW Ickes, deputy PAW Davies, and their entire staff.

Recommendations made by the committee, as an outgrowth of investigations conducted during the 78th Congress, included:

1. That there is a continuing need for "further incentives" for crude discoveries.

Urges Revenue Act Change

2. That a change be made in the practice of the Internal Revenue Bureau which treats certain geological and geophysical expenditures as capitalization instead of allowing them to be charged off as expenses. The committee said that this situation should be given legislative attention by Congress.

3. That the burdensome routine and delays in securing materials for foreign oil operations and licenses to export be corrected. The committee pointed out that in addition to PAW, the Foreign Economic Administration also acts as a claimant for materials to be used abroad and this complicates the procurement process and places a burdensome routine on efforts to obtain export licenses.

4. As soon as necessary clearances can be properly granted, oil industry personnel should be permitted to return to liberated areas in Europe to rehabilitate vital petroleum facilities.

Reviews Three Years of War

The committee also gave its endorsement to studies looking towards promotion of "world-wide use of petroleum products by peace-loving countries on terms economically sound and reasonable, without exploitation," adding that "we commend the consideration of this problem by those in authoritative positions in our government, in connection with international agreements and treaties."

In the foreign field, the report contained the following highlights:

1. Exclusive of Russia, the United Nations' program of foreign crude production called for an output of about 1,670,000 b/d during the fourth quarter of 1944, or an increase of about 375,000 b/d over actual production in December 1943.

2. Production program for the Middle East (Iran, Iraq, Arabia, Egypt and British India) was scheduled at about 499,000 b/d for the fourth quarter compared with about 390,000 b/d for December 1943, or an increase of approximately 25%.

3. In the Caribbean area (Venezuela, Colombia and Trinidad) the fourth quarter program was about 922,000 b/d compared with approximately 670,000 b/d in December of 1943, or an increase of about 38%.

The Caribbean Picture

On the Caribbean angle, the committee said that a "substantial" amount of productive capacity also has developed in excess of current requirements, but that this excess is chiefly in the heavier grades of oil. It added that it "is necessary to drill more wells. . . . To build and increase the capacity of pipelines and to add to other facilities required to move the oil either to export or to refineries."

4. All the refineries of the United Nations are now producing at capacity, except when limited by transportation availability, principally tankers. "The foreign refineries of the United Nations have substantially contributed to the war program. Many of them have operated —and some are still operating—in active combat theaters under partial or complete blacked-out conditions, with the material and food supply problems complicated beyond normal war-time restrictions by shipping difficulties. Several foreign refineries have been bombed or shelled by the enemy. Without these foreign refineries, the present favorable war situation would have been impossible."

5. About 83% of the aviation gasoline program is now completed in foreign refineries. The status of the Russian program is unknown. With this exception, and Mexico, the last remaining presently authorized facilities will be completed in the second quarter of 1945. "The fact that there has been so much construction of foreign facilities during the emergency has been a major accomplishment of PAW."

On the question of crude prices, the committee treaded "lightly and politely," merely suggesting the advisability of "a further impartial and thorough investigation."

After reviewing the transportation difficulties encountered at the outbreak of war, because of tanker diversions and the problem of mobilizing the thousands of tank cars scattered throughout the country, the committee termed the accomplishments to date as one of "the outstanding achievements of the war."

The recent emergency, brought about by increased military tanker demands, was spotlighted also. In discussing this, committee said:

"A radical change took place in transportation in August, September and the first two weeks of October. Overland movements declined to 1,402,206 b/d which was directly attributable to reduced rail movements. War developments recently necessitated the transfer to military use of some of the few remaining tankers moving oil from the Gulf Coast to the East Coast."

Krug Sights Only Few Snags on Synthetic

NPN News Bure u

WASHINGTON — WPB Chairman Krug this week predicted that the supply situation on carbon black needed for manufacture of synthetic rubber "will be tight" in the first quarter of this year, but said that all first-quarter needs for synthetic rubber production could be met with existing facilities except in the case of butyl.

Some relief of the carbon black shortage will come with construction of new plants costing $19,500,000, WPB said, but an offsetting factor may be the acute lack of manpower.

Regarding other materials needed in synthetic-rubber production, WPB said that production of high-tenacity rayon cord probably would continue as "the most serious bottleneck in the tire program (see table) as the rayon industry would fall 19,100,000 lbs. short of meeting essential material needs in the first quarter.

Because cotton tire cord will have to be substituted to cover the deficiency of rayon cord on a poundage ratio of 1.3 to 1, WPB said, "cotton cord needs for tires will amount to 57,700,000 lbs. for the first quarter of 1945.

Material needs for the first quarter are given below, together with figures on consumption on the third quarter of 1944.

WPB said the figures were compiled after taking into account the freezing of passenger car tire production in first quarter to about 5,000,000 tires, in order to release facilities for production of urgently needed military truck tires.

(Long Tons)

	Material Consumption (Estimated) 1st Quarter 1945	Materials Consumed 3rd Quarter 1944
Synthetic Rubber		
Buna S Type	163,000	152,467
Neoprene (1)	14,600	12,196
Butyl	11,500	3,329
Buna-N (1)	3,400	3,554
Total	192,500	171,546
Natural Rubber	36,400	32,883
Reclaimed Rubber	51,200	56,141
Grand Total	280,100	260,570

(1) Not used in manufacture of tires and tubes.

(Millions of Pounds)

Carbon Black		
Channel	133,000	107,235
Furnace	101,480	84,354
Total	234,480	191,589
(Millions of Pounds)		
Tire Cord & Fabric		
Rayon	(1)48.6	24.4
Cotton	57.7	47.1

(1) Maximum estimated production capacity of the rayon industry.

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Ickes Reports New 1944 Peaks for All Oil and Gas

NPN News Bureau

WASHINGTON — All branches of the petroleum and natural gas industries set new records in 1944, Secretary of the Interior Ickes announced this week, as production of crude oil during the year, estimated at 1,678,000,000 bbls., soared 11% above 1943.

At the same time, Mr. Ickes noted the most significant change in demand for refined products in 1944 was the gain in demand for motor fuel "to an estimated total of 738,000,000 bbls.—exceeding the previous record set in 1941 by more than 6% and representing a 19% gain compared with total demand for 1943." Civilian consumption remained about the same as in 1943, so the upsurge in demand reflected expanded requirements of our armed forces and for export, it was pointed out.

About 90% of the total 1944 gain in crude production came from Texas and was supplemented by substantial increases in California and Louisiana. Estimated value of crude petroleum at the well was about $2,061,000,000—"the largest increment due," Mr. Ickes said, "to the volume gain in production, but a further substantial increase resulted from government payments to stimulate production from 'stripper' wells in August and succeeding months." Average value per bbl. rose from $1.21 in 1943 to about $1.23 in 1944.

Speaking of natural gas, the secretary said the marketed production of that product increased about 9% in 1944 to an estimated total of 3,735,000,000,000 cu. ft. compared with 3,415,000,000,000 in 1943. Less expansion in demand for industrial applications was indicated in 1944 than occurred in 1943. Total value of natural gas at points of consumption in 1943 was estimated at $820,000,000.

The natural gasoline industry increased its output of light products 13% in 1944, the report continued, to approximately 4,200,000,000 gals., of which 3,040,000,000 were natural gasoline and cycle products and 1,160,000,000 were liquefied petroleum gases. Value of all products at the plants was about $185,000,000.

Mr. Ickes noted that all the fuels—anthracite, bituminous coal, coke, natural gasoline and liquefied petroleum gases, and petroleum—registered gains last year.

20 More U. S. Tankers Given Byrnes' O.K.

NPN News Bureau

WASHINGTON — The Maritime Commission this week was preparing to close contracts with American shipyards for 20 tankers to be built in the last six months of 1945, following authorization from War Mobilizer Byrnes to proceed immediately with their construction.

A Byrnes statement said that the action was taken because, during the generally tight shipping situation, he wished to avoid any delay in provision of components for necessary ship construction. WPB Chairman Krug had advised that placing of orders for components now would avoid interruption in the production of essential materials for ship construction beyond the second quarter of 1945.

No Details on Tankers

"Director Byrnes also expresses the hope," the statement read, "that this additional authorization, along with shipping availabilities now in hand, will meet essential military requirements and still leave a balance for other purposes."

In addition to the 20 tankers, Byrnes also authorized maritime commission to proceed immediately with construction of 102 C and Victory types, 40 C-I Mavi type and 24 Z-EC 2 (Liberty) ships for delivery in the last half of next year.

No details as to type or capacity of the 20 tankers to be built were available at Maritime Commission today, but an announcement of contract awards for the vessels was expected within a day or two.

Since beginning of 1943, a total of 463 tankers has been produced in the U. S. shipyards, as follows: 1943—January, 5; February, 9; March, 12; April, 16; May, 17; June, 14; July, 16; August, 21; September, 29; October, 40; November, 37; and December, 37. 1944—January, 16; February, 20; March, 20; April, 18; May, 21; June, 20; July, 19; August, 16; September, 19; October, 19; November, 22.

The Maritime Commission anticipates that an additional 173 tankers of various sizes will be produced during the first six months of next year broken down as follows: 130 "major types" (T-2, and T-3 types which range in capacity from 135,000 to 141,000 bbls.) 6 for private operators (majority being T-2 type); and 37 of the "smaller" type (T-1, having capacity of about 125,000 bbls.).

In addition, contracts have been let for construction of 69 tankers during the last half of 1945, which is in addition to the 20 authorized by Byrnes.

Demand for Motor Fuel Up 11% In October, Bureau Reports

Special to NPN

WASHINGTON—Actual motor fuel demand totaled almost 65,000,000 bbls. in October, 1944, up 11% over October, 1943, the Bureau of Mines announced this week. (*See p. 24 for estimate of January demand.*)

At the same time, the Bureau said that total motor fuel demand for the first 10 months of 1944 amounted to about 614,000,000 bbls. or 19% above same period in 1943. The yield of gasoline from crude oil in October, 1944 was 40.1%, highest monthly yield since March, 1942.

Stocks of finished gasoline amounted to 65,886,000 bbls. on Oct. 31, up 972,000 bbls. during the month, while stocks of distillate fuel oil gained 3,665,000 bbls. Stocks of residual fuel oil, however, declined 429,000 bbls. Stocks of refined oils increased 2.8 million bbls. in October and were 21.8 million bbls. larger than on Oct. 31, 1943.

The crude oil capacity represented by refinery data in the Bureau's report was 4,938,000 bbls., indicating an operating ratio of 94% compared with 90% in October 1943 and 82% in October, 1942.

Turning to production of crude oil, the Bureau noted a decline of 26,000 b/d in October to 4,740,000, following the large gains of August and September. The decline was said to have resulted chiefly from reductions in output of Texas (21,000 b/d), California, (7,000 b/d), and Kansas (5,000 b/d). A new record of 358,000 b/d was reported in Louisiana.

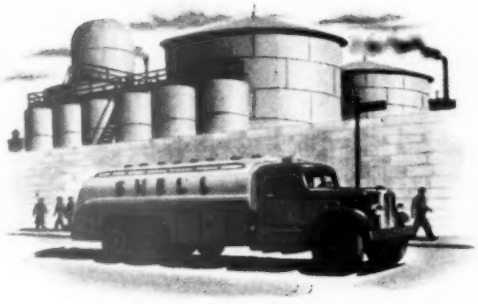
Oil-well completions totaled 1,194 last October, 163 fewer than in September and total initial production of 264,000 bbls. was 38,300 below that of September. The number of active drilling rigs, which had increased consistently from 3,079 in March 1944 to 4,340 in September, decreased to 4,309 on October 31.

WASHINGTON

(*Continued from p. 10*)

drop out of the picture, however, is the group that was chairmaned by Sen. Bennett Champ Clark, of Missouri, and which had the job of looking into supply shortage in the middle west. Clark isn't in the Senate anymore and there appears to be no particular desire on the part of anyone to prolong the committee's life.

There's some opposition developing in government circles to the application of Reynosa Pipeline Co., of Corpus Christi, for authorization to export natural gas from Texas to Monterrey, Mex. Reason is that Mexico has a law requiring use of Mexican production, if available, and that Petroleos Mexicanos has just found 100 feet of clean gas sand in a well being drilled just across the border in the territory Reynosa would serve . . . Federal Trade Commission chairman for 1945 is Ewin L. Davis, of Tennessee, who moves to top position as a result of the commission policy of rotating the chairmanship annually. Robert E. Freer, of Ohio, was chairman in 1944 . . . truck transportation of petroleum products during November was 1.7% above the October level and 3% above the November 1943 level, according to American Trucking Assn., Inc. . . . Tire industry workers who maintain perfect attendance records during a period which started Jan. 1 will receive official certificates of commendation from the war department.



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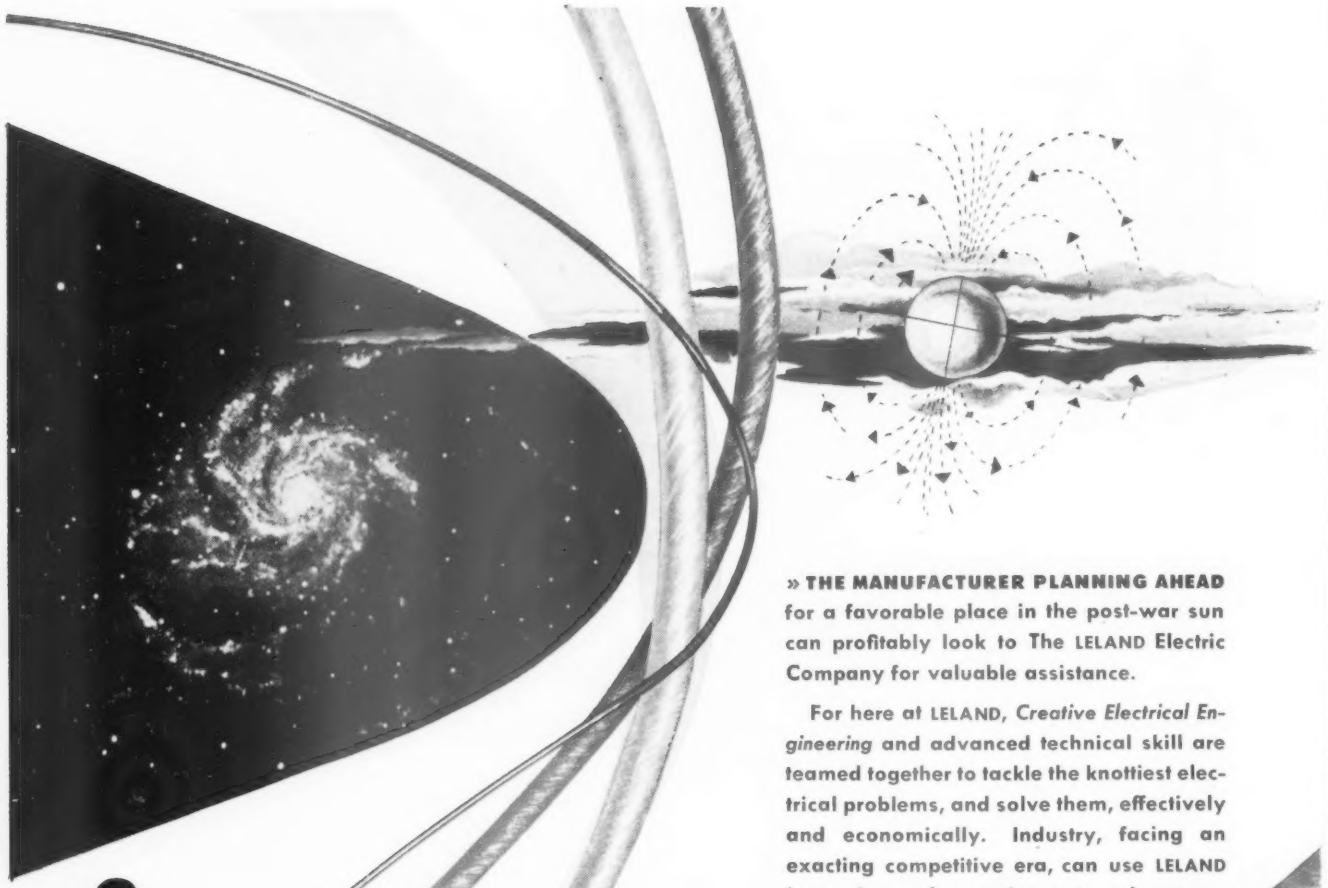

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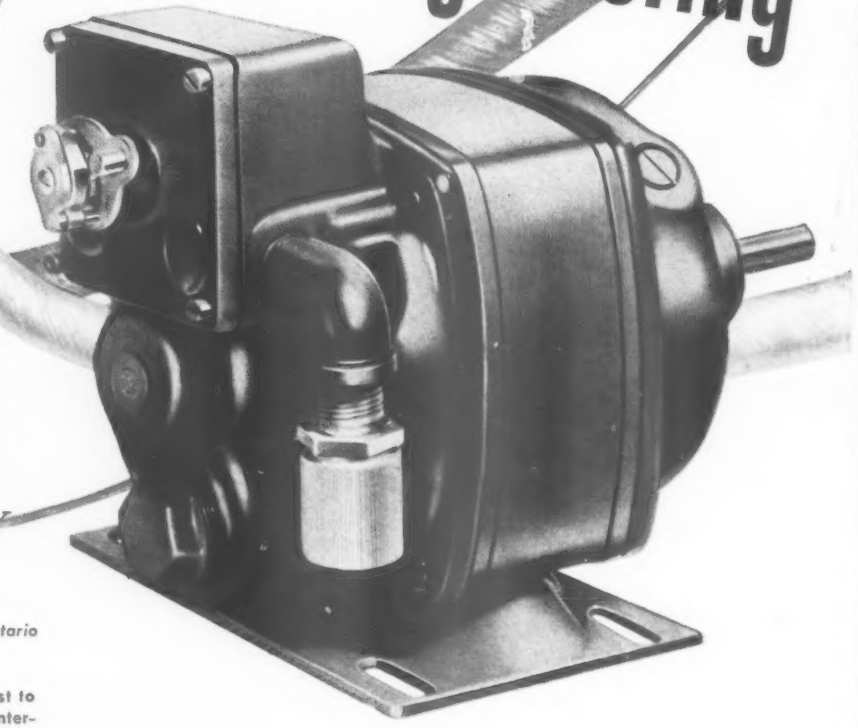

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Should the Credit Card Business Be Restored?

Public Should Not Be Denied This Right, Says Executive of Major Company

As Told to Herb Taylor, NPN Staff Writer

This article, the second in a series on whether the credit card business should be restored, gives the opinion of the vice president of a large major oil company.

This executive, like the general credit manager of another large oil company who "let his hair down" and gave his opinion in the Dec. 20th issue of NPN, asked that his name not be used. However, he is nationally known in oil circles for his sound thinking. His opinion presents an entirely different view on credit cards than that of the interview reported Dec. 20.

Future articles, on both sides of the controversy are in the making. We would like more opinions on the subject. We would particularly like to hear from independent jobbers and association officers or members. Send in your opinion either in the form of a letter, or an article in detail. If you object to having your name used, your communication will be held in strict confidence.

HAVE European totalitarian ideas infiltrated into our economy in the thinking of many oil company credit men on the subject of credit cards?

Is business being driven from service stations to tank wagon delivery, because the customer prefers credits?

Do independent dealers look on the suppression of credit cards as an un-American restraint? Are they quietly giving credit—regardless?

No sooner had the Dec. 20th issue of NPN reached the front office of one of the country's leading major oil companies than the vice president of that company registered his vote on the subject of credit cards with a most emphatic "Yea."

"Keep me out of this", he said, but—

Terms Denial Totalitarian

"The thinking of too many credit men on the subject of credit cards shocks one into a realization of how far European totalitarian ideas have infiltrated into our economy.

"If my customers desire credit and such an arrangement can be made to our mutual advantage, who has the right to say nay?

"Since when did so-called postwar planning include immunity for featherbedding?

"Today business is being driven from service stations to tank wagon delivery, because the customer prefers credit. Throughout the United States the independent dealer is quietly giving credit, because both he and his customers are out of sympathy with such un-American restraint. How many garages in family hotels are not including the servicing of tenants' cars in their monthly statements, and why shouldn't they?

Based on False Philosophy

"The fact that credit is one of the pitfalls of the business man is no sound reason that its use should be denied those who use it soundly. The prohibition of alcoholic drink was based on this philosophy.

"No, the answer is that under the present laws of the land, except for wartime restrictions, business and the buying public cannot be denied this device if they prefer it. Nor should they be."

The opinions of dealers on the subject of credit cards may be judged in some degree by the latest figures on a survey, released Dec. 27 by the Petroleum Division of the National Assn. of Credit Men. This survey, which was partially completed last May, and reported in the July 5 issue of NPN, has just been completed.

33% Answered Questions

A questionnaire was mailed to 1200 dealers throughout the country. A 33% return on the questionnaire gives the following results:

1. In your opinion has the average car owner been inconvenienced by not having a credit card and having to pay cash?

Yes—13% No—86% Some—1%

2. Do you believe that car owners should have credit cards?

(a) Local Use—35%

(b) Vacation Travel—65%

3. Can you serve your customer better when he—

(a) pays cash—80%

(b) Presents a credit card—16%

(c) No difference—4%

4. Would you be in favor of:

(a) Return of credit cards on a liberal basis—20%

(b) Return on a restricted basis—39%

(c) No credit on petroleum products at service stations—41%

5. Did the use of credit cards make it necessary for you to carry more credit yourself?

Yes—48% No—52%

6. Did you suffer credit losses?

Yes—56% No—44%

The estimated percent of credit losses ran from 30% in the case of one dealer reporting to less than ¼% in the case of the reports of 15 dealers. Nine reported 10% losses, 11 reported 3%.

The cost of credit cards to oil companies was also part of a survey made by the National Assn. of Credit Men. The result of that survey giving the cost figures on a per dollar and per gallon basis are shown below: (However, H. E. Butcher of that association, at the time the figures were released said that there was a possibility of error in the figures due to changes in oil company personnel, the new men not being too familiar with the actual situation for the period under consideration.)

	—Cost per Dollar—		—Cost per Gallon—	
	Oct. 1942	Oct. 1943	Oct. 1942	Oct. 1943
High	.04564	.04500	.00930	.00922
Median	.03406	.02225	.00681	.00450
Low	.02200	.00100	.00460	.00020

	—Cost per Dollar—		—Cost per Gallon—	
	1941	1943	1941	1943
High	.100000	.15000	.02031	.03040
Median	.03949	.03606	.00816	.00720
Low	.02170	.00150	.00430	.00030

Texans Fighting Oil Treaty Summarize State's Stake

AUSTIN, Tex. — Nine million barrels of crude oil are required to fill the 34,828 miles of pipelines in the state of Texas, according to data worked up by the statewide committee of oil operators in a booklet used in its fight against ratification of the Anglo-American oil treaty.

Some of the other facts the committee's statisticians found:

Today in Texas 128 plants are capable of processing 5,237,528,000 cubic feet daily of casinghead and natural gas into gasoline.

The state has 113 refineries with a total daily capacity of 1,456,350 barrels of crude oil.

Thirty-seven carbon black plants capable of extracting carbon black from 1,030,750,000 feet of gas each day are in operation in Texas, mainly in the Panhandle region.

Some 48,000,000 acres of Texas land are under lease for oil and gas. Total rentals and bonuses on these leases amount to $70,000,000 annually.

There are 169,400 persons in the state employed by the oil and gas industry.

There are 140 counties in the state producing oil and 36 producing gas.

Bowser, Inc., Wins Third Star

Special to NPN

FORT WAYNE, Ind.—Bowser, Inc., through its president, R. Hosken Damon of Chicago, has been notified by Adm. C. C. Bloch, general chairman of the Navy Board for production awards, that the firm has been awarded the third star for its Army-Navy "E" flag.

DETROIT PUBLIC LIBRARY

Gill Hits Surveys Hinting Oil 'Profiteering'; Finds Earnings Still Below General Average

NPN News Bureau

CLEVELAND — Surveys of oil company earnings reports with headlines giving an impression to the public that oil companies are "war profiteering" are most unfortunate, Dr. John D. Gill, petroleum economist and director of the Atlantic Refining Co., declared this week.

Dr. Gill said that following the publication and tabulation of nine months earnings reports, the oil industry has been getting a large amount of publicity because it is almost the only large industry to show a gain in net earnings so far in 1944 as compared with 1943.

For instance, Dr. Gill pointed out, in a recent article describing the earnings of the nation's leading companies for the first nine months, the *New York Times* stated, "The increase in the earnings of the companies included in the survey is attributed largely to the petroleum group."

He also quoted from the National City Bank survey of earnings, which commented that the petroleum industry was an "important exception" to the relatively stable earnings, and added: "A major share of the gain in total net income for the group was accounted for by the 13 companies in the petroleum industry, which had a 27% increase this year in sales . . . and a similar rise in income. Exclusive of the oil group, the net income (of all other groups) was up only 2%."

It is doubly unfortunate, Dr. Gill said, that there is probably no general realization that to be far ahead of the rest of industry earningwise is an unusual experience for the oil industry. For example, he said, in each of the last five years the oil industry's rate of return on net worth has been lower than that of all industry, and not in the last 10 years has the oil industry approached manufacturing and trading, as the following table shows:

Rate of Return on Net Worth

	All Industry	Manufacturing & Trading	Oil Industry
1934	3.5	4.3	2.9
1935	5.0	6.6	5.2
1936	7.3	10.2	7.5
1937	7.2	10.6	10.0
1938	3.8	5.0	4.6
1939	6.2	8.4	5.4
1940	7.4	10.3	6.8
1941	9.4	12.3	8.9
1942	9.0	10.1	6.7
1943	8.7	9.9	8.3

Commenting further, Dr. Gill said: "The articles mentioned above are misleading in that, while emphasizing the fact that it is the oil industry alone which is responsible for rising earnings of a total industry group, they completely fail to point out that even now, with a substantial gain in profits over 1943, the oil group is still behind the average of all industry with regard to rate of return on net worth. It is not possible to ascertain this fact at all from the *Times* article, but examination of a table accompanying the National City Bank report reveals that for the first nine months of 1944 the oil group earned a rate of return of 8.6%, as against 8.9% for total manufacturing and 8.8% for the whole industry group.

"Thus it appears that it is only now, after three years of war, that the petroleum industry is beginning to catch up to the good earnings which other industries have been enjoying over the whole period, and not even now has the gap been completely closed."

Four Months—and On Stream

LOS ANGELES — Four months ago the Newhall Refining Co. plant in Newhall went up in flames.

Last week, the plant, rebuilt, went on stream.

The refinery, owned by William D. Parks and Edward A. Ericson, caught fire last Aug. 11, and before the flames could be controlled, loading racks, tank farm and cooling tower were destroyed.

Tire Plant in Ploesti Area To Resume, Goodrich Says

NPN News Bureau

CLEVELAND—A tire plant, Banloc, near the Ploesti oil fields in Rumania, liberated from German occupancy in August, soon will resume manufacturing operations, it is learned from officials of the B. F. Goodrich Co.

The plant, with an annual capacity of 100,000 tires, had been running on a limited basis under German direction, Goodrich officials say.

The plant, built and operated by Goodrich for Rumanian interests sponsored by the government until the outbreak of the war in Europe, had not been heard from for four years until recently.

The output of the plant, when production is resumed, will go to Allied armies.

A.P.I. Chart Traces Oil Flow From Well to Finished State

NPN News Bureau

CLEVELAND — A flow chart tracing crude oil from well to finished products, is the latest publication of the American Petroleum Institute.

The flow-chart, 17 x 22 inches, printed in two colors traces crude and gas to the well, and, in a manner that a novice can understand, shows the processes followed until they reach the finished state. These include natural gas, for homes and industry; high octane aviation gas; automotive gasoline; finished kerosine; domestic heating oil; hydrocarbon gases; industrial fuel oil; finished lubricating oils; wax paraffin; gas oil; coke; and asphalt.

The flow chart utilizes the space on the back with illustrations showing the distribution of petroleum products from refineries, terminals, bulk stations, jobber bulk plants and retail service stations.

One section is devoted to the products coming from natural gas, refinery gas, light distillates, medium distillates, heavy distillates, and residues. These include everything from synthetic rubbers to paving asphalts. Little known items to the general public include such things as inks, paraffin wax for chewing-gum, wax for the laundry, for sealing, etchers, saturating, insulating and match cardboard; residues for salves, creams, ointments and petroleum jelly; explosives, synthetic plastic waxes.

William R. Boyd, Jr., chairman of P.I.W.C., comments that the chart will give a clearer understanding of the problems of petroleum supply created for the industry by the war.

Urge Open Oil Pact Fight

Special to NPN

AUSTIN, Tex.—Regardless of the P.I.W.C. substitute Anglo-American oil treaty, the Texas oil operators who have organized to fight the original agreement want both plans threshed out on the senate floor.

Grady H. Vaughn and Glenn H. McCarthy, co-chairmen of the operators' committee, reiterated that they want no quiet withdrawal of the proposed treaty, but want to see it soundly defeated on the Senate floor. Full hearings on all proposals were asked.

Revised Surplus Guide Ready

NPN News Bureau

WASHINGTON—A revised edition of the Buyer's Guide for Surplus Property is now available at the Superintendent of Documents, Washington 25, D. C., at 10 cents a copy, Mason Britton, Surplus War Property Administrator announces.

The Buyers Guide, Mr. Britton said, is not a listing of surplus property now available for sale through disposal agencies. Its function is to show the addresses of the offices disposing of surplus property and the types of property that have been assigned to each agency for disposal.

Long Beach Wells Paying Out

NPN News Bureau

LOS ANGELES—Los Angeles County flood control district's venture into oil drilling in the Long Beach area netted a return of $5403.18 in October, it was disclosed last week.

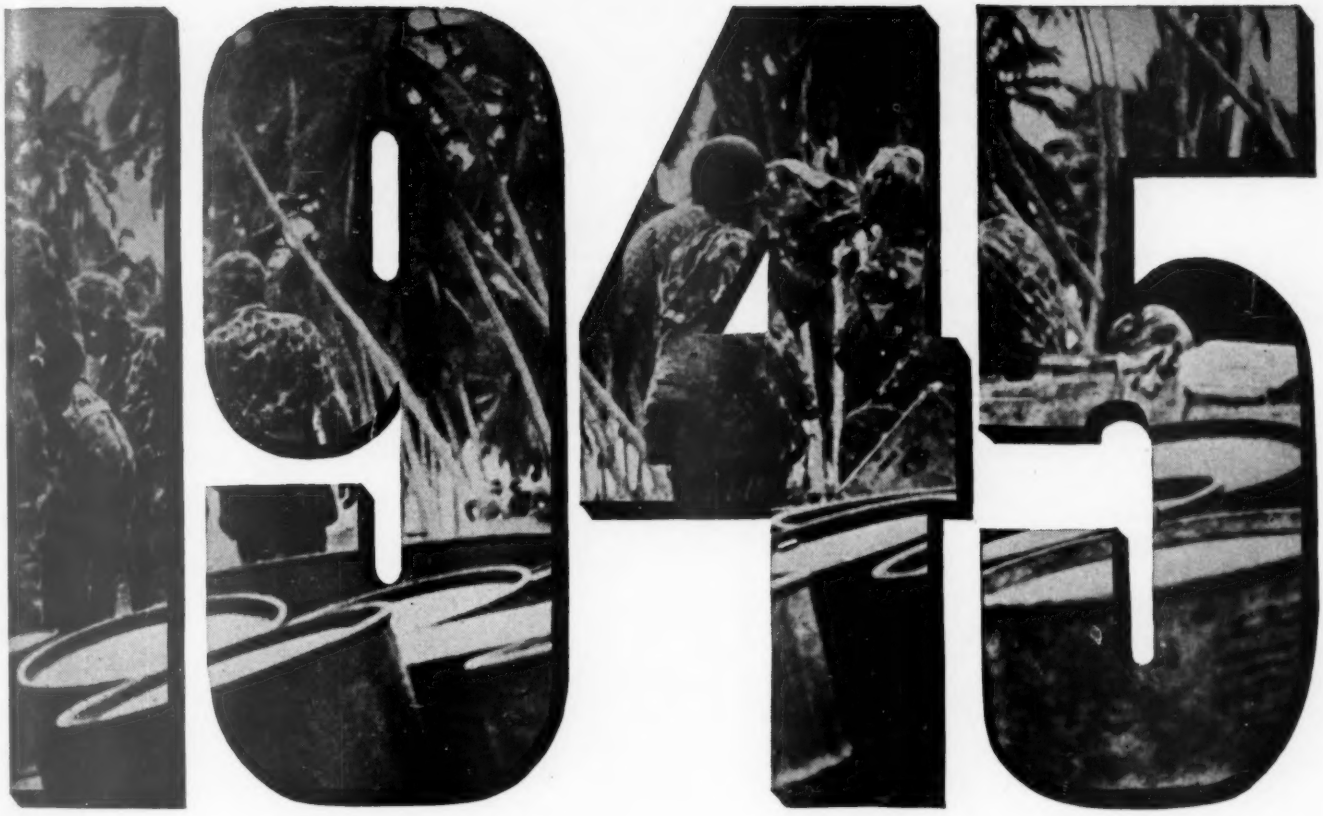
Wells sunk by the Continental Corp. and Continental Development Corp. have yielded them $162,227 since operations were begun in May of 1942.

The flood control district receives 25% of the net proceeds, which are used in its work in the Long Beach area.

Kentucky Tax Tops Million

Special to NPN

FRANKFORT, KY.—Total gasoline tax accrual collections for October amounted to $1,059,749.30, A. S. Portwood, supervisor of gasoline tax collections reports.



New Year . . . New Hopes

In days past, no people have been gayer than ours in welcoming a New Year.

Today, no people face a New Year with deeper resolve or more fervent hope.

In the dawn of this year, the eyes of America are turned toward distant shores. The prayer of all is that, before the last page of the calendar is turned, "1945" will have been written as history's greatest symbol of glorious victory, joyous homecoming and lasting freedom.

AMERICAN FLANGE & MANUFACTURING CO. INC., 30 ROCKEFELLER PLAZA, NEW YORK 20
TRI-SURE PRODUCTS LIMITED, ST. CATHARINES, ONTARIO, CANADA

Tri-Sure
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The product we make is small; it can be held in the palm of your hand. But because its war-time job is to protect the drums of fuel that keep planes flying and tanks rolling, and because it does that job well, the Tri-Sure Closure, in its way, is helping to "speed the day" — in 1945.

THE LIFE STORY OF A FAN BELT

1 *First it* STRETCHES

But..HERE'S A HORSE OF

Thermoid

THERMODIZED *Pre-stretched* FAN BELTS

Join the thousands of dealers who have found increased sales and profits with Thermoid—and extra profits because of the Thermoid Sales Reward Premium Plan. Ask your jobber about the Thermoid Fan Belt Program, or write to us. THERMOID CO., TRENTON, NEW JERSEY.

2 *Then it* SLIPS

3 *Then it* WEARS

4 *Then it* FAILS

A Thermoid Fan Belt was removed from a Buick, and the weight of a horse suspended from it. When put back on the car, the belt performed perfectly at the same adjustment! That's convincing proof of the advantages of Thermodized Pre-Stretching.

A DIFFERENT COLOR

U. S. May Seek Oil's Views on Research

NPN News Bureau

WASHINGTON — Oil men, along with leaders of other large industries such as coal, railroads, steel and chemicals, soon may be called upon to present to Congress their views on government financing of scientific research after the war.

Extensive hearings now are being planned by the Senate Kilgore subcommittee on war mobilization, to start soon after the committee reports its own findings to the Senate in January. At first, only the National Association of Manufacturers and U. S. Chamber of Commerce will be asked to testify, but there is a definite possibility, NPN was told, that the committee may later summon heads of individual industries, including petroleum.

Review Wartime Achievements

The committee's new report will review the wartime scientific research program—which has been "largely government financed"—and will urge that Federal agencies engaged in scientific research be co-ordinated postwar under a single agency. In addition, the Kilgore group will ask that government financing of scientific research in industry be continued after the war, "but on a greatly curtailed basis."

"The committee feels," said a spokesman, "that government expenditures for scientific research should be limited after the war to fields in which no individual company believes that it is its responsibility to finance a given project which is in the public interest, or in which a group of companies could logically engage but are reluctant to do so because they fear prosecution under the anti-trust laws."

On the latter point, the committee thinks there is no legal basis for such fear, because anti-trust laws are aimed only at combinations in restraint of trade—not at "companies' joining in scientific research in the public interest."

Gasoline Demand of 61,000,000 Bbls. Forecast By B. of M. for January, Up 15% in Year

NPN News Bureau

WASHINGTON — The Bureau of Mines this week estimated that total motor fuel demand in January, 1945 would reach 61,000,000 bbls., an increase of 15% over actual demand in January, 1944, and reported that the total demand for 1944 will approximate 738,000,000 bbls., a gain of almost 19%.

Indicated motor fuel yield for 1944, Bureau said, is about 39.4% as against 37.1% in 1943, adding that the "gain in demand for motor fuel has been the outstanding factor in the demand for refined products in 1944. The combined total demand for residual and distillate fuel oils will show an estimated increase of only about 9% compared with 1943." Yield of 39.1% was forecast for January by the Bureau, compared with 39% estimated for December, and 38.73% actual yield in January, 1944.

Daily average supply of domestic crude estimated by Bureau to meet January market demand is 4,738,700 bbls., 312,500 bbls., or 7.3% higher than the demand in January 1944.

Production of domestic crude during 1944 was estimated at 1,678,000,000 bbls., an increase of about 11% compared with 1943, and the demand for domestic crude should reach 1,700,000,000 bbls., indicating a drop in domestic crude stocks of about 22,000,000 bbls. during the year.

Daily average demand, the Bureau reported, rose from 4,478,000 bbls. in the first quarter to 4,623,000 bbls. in the second quarter, to 4,735,000 bbls. in the third quarter, and may amount to about 4,740,000 b/d in the fourth quarter. Forecast for the first quarter of 1945 indicates a demand for domestic crude of about 4,730,000 b/d—assuming a moderate drop in production and a corresponding reduction in stocks of domestic origin.

Finished and unfinished gasoline inventories totaled 78,274,000 bbls. on Oct. 31, or 9,229,000 bbls. more than the same date of 1943. A seasonal increase of 3,300,000 bbls. in finished gasoline stocks is estimated in January compared with a gain of about 5,500,000 bbls. in January, 1944.

Daily average crude production and runs-to-stills during the five weeks Oct. 29 to Dec. 2 were about 4,727,000 and 4,630,000 bbls. respectively. During the period, domestic crude stocks dropped about 21,000 b/d, indicating a demand for domestic crude of 4,748,000 b/d.

SUMMARY OF FORECAST FOR JANUARY 1945
(Barrels)

	Forecast Jan. 1945	Actual Jan. 1944
DEMAND FOR MOTOR FUEL*		
Total Domestic & Export Demand	61,000,000	53,114,000
SUPPLY OF MOTOR FUEL		
Straight Run & Cracked Gasoline Production	56,340,000	51,575,000
Natural Gasoline Used at Refineries	6,060,000	5,382,000
Total Refinery Production	62,400,000	56,957,000
Other Natural Gasoline and Imports	1,900,000	1,683,000
Increase in Finished Stocks	3,300,000	5,526,000
CRUDE OIL REQUIREMENTS		
Percent yield of Gasoline from Crude	39.10	38.73
Refinery Crude Required	144,100,000	133,161,000
Daily Avg.	4,648,400	4,295,500
Domestic Crude Runs	139,900,000	130,042,000
EXPORTS		
Fuel & Losses	7,000,000	6,892,000
Total Demand for Domestic Crude	146,900,000	136,934,000
Daily Avg.	4,738,700	4,417,200
Decrease in Domestic Stocks		1,167,000
Actual Production		135,767,000
Daily Average		4,379,600

*The term "motor fuel" as used in this report includes gasoline and naphtha used for all purposes but does not include heavier distillates used in the operation of tractors or burned in diesel engines.

Doubt Jap Report of Pine Tree Plane Fuel

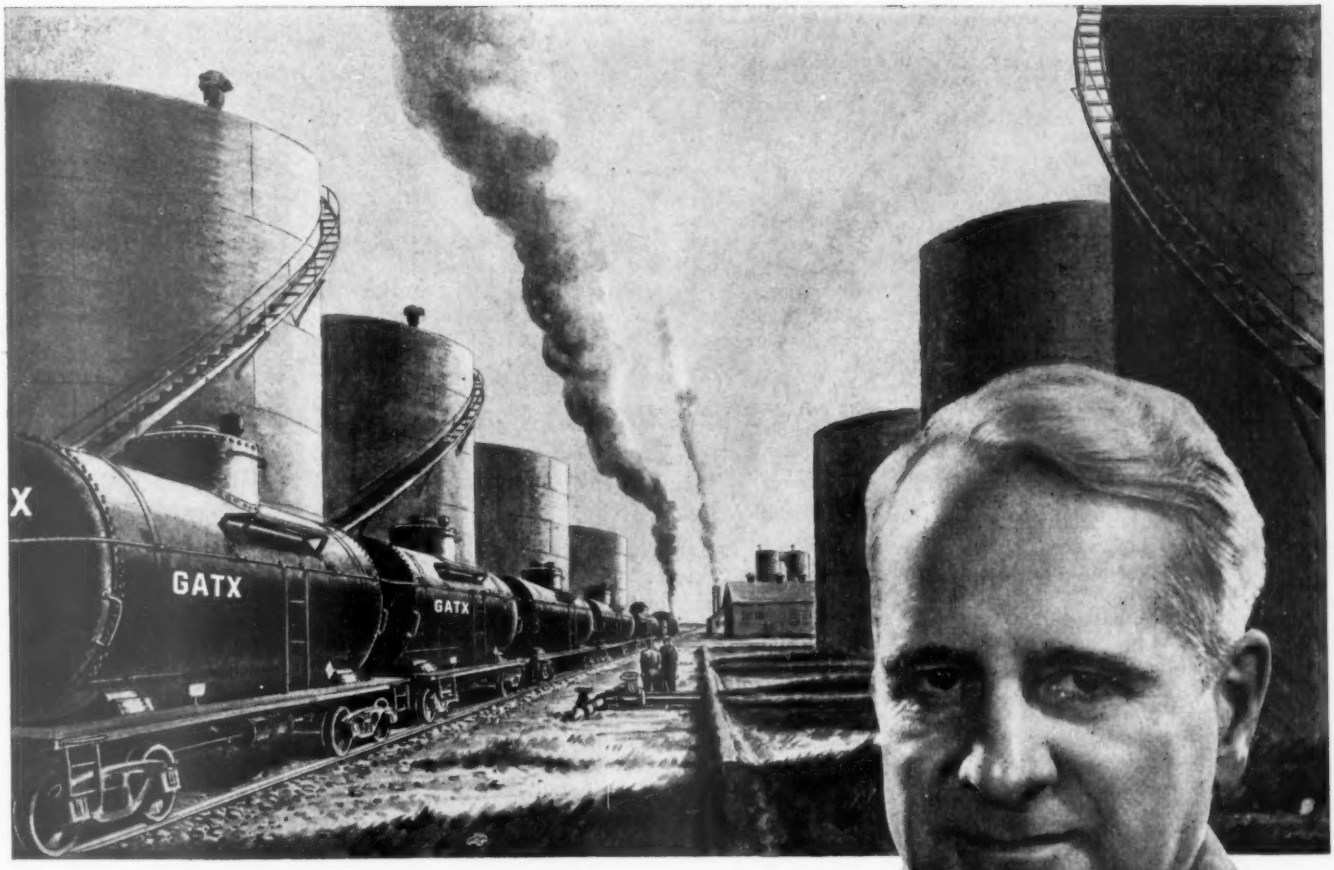
NPN News Bureau

WASHINGTON — Tokyo reports that the Japs are mass-producing high-octane aviation gasoline from their pine trees and that it is equal if not superior to that type of fuel obtained from petroleum were greeted with some skepticism this week by informed observers at the Bureau of Mines and the Department of Agriculture's forest products division.

A Domei news agency report said the new synthetic gasoline was being produced through a "simple patented process, and already is being mass-produced on an industrial scale." Agriculture officials said, however, that "mass - production" of high - octane aviation fuel might mean as much as 5000 or 10,000 gallons daily.

"We in America know," one said, "that it is possible to make gas out of resin and turpentine taken from trees. It would then be no particular trick to crack these products to form isoprene, and then by hydrogenation to form iso-pentane, for high-octane gasoline."

While no high-octane is currently being produced from the products of southern pine trees in the United States, it was said that the oleo-resins are being converted into ingredients for synthetic rubber production.



When you're looking ahead, it's well to know what's behind you

Now, in your planning, is the time to ask yourself, "What can I count on in the Present, to back me firmly in the Future?"

If yours is a liquid product—or uses a liquid in its manufacture—General American Tank Storage Terminals give you *known* competitive advantages. General American strategically located Terminals are designed for service to the individual producer: to save the cost of your own facilities—to give your product the benefit of speed with safety, access to world markets, and planned attention to your particular needs.

Remember in your planning for the future, you can always rely upon General American Terminal Service.

Six Exclusive General American Advantages for YOU:

1. **STRATEGIC LOCATIONS.** Low rail and ocean freight rates.
2. **RELIABLE CUSTODIANSHIP.** Our warehouse receipts are highest type of collateral everywhere.
3. **INDEPENDENT OWNERSHIP.** Strict privacy. We do not buy, sell, or refine oils.
4. **MODERN PROTECTION.** Latest safety appliances; lowest insurance rates; minimum evaporation losses.
5. **LARGE TANK CAR FLEET.**
6. **NO CONTAMINATION.** Separate pumps, lines, storage zones for dissimilar commodities.

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Corpus Christi, Texas • Galena Park, Texas *(Port of Houston)*

A Division of General American Transportation Corporation

PAW Empowers Refiners to Boost Premium For Civilians; Explains Rule Limiting Lead

NPN News Bureau

WASHINGTON — PAW this week announced issuance of Admt. 3 to PDO 21, effective Jan. 1, which will permit refiners to increase the output of premium gasoline for essential civilian vehicles from present 105,000 b/d to about 165,000 b d. (*See NPN, Dec. 27, p. 3*).

The order was amended by changing paragraph (b) to read:

"(b) Limitation on manufacture of *premium motor fuel.* After Dec. 31, 1944, the percentage of premium motor fuel manufactured by any person:

"(1) in the states of Washington, Oregon, California, Nevada and Arizona and in the territories of Alaska and Hawaii, based on his total manufacture of gasoline, shall not exceed 27/80 of the percentage of premium motor fuel, based upon total gasoline, which he manufactured during the base period; and

"(2) in all other states of the United States, based upon his total manufacture of gasoline, shall not exceed ⅜ of the percentage of premium motor fuel, based upon total gasoline, which he manufactured during the base period.

Figures Start Jan. 1

"Computation to determine that the amount of premium motor fuel manufactured by any person is within this limitation shall be made on the basis of successive periods one calendar month long, the first of which shall commence on Jan. 1, 1945.

"Premium motor fuel delivered for direct military uses in equipment owned and operated by the Army or Navy may be manufactured in addition to the quantity permitted to be manufactured under paragraphs (b) (1) or (b) (2). When submitting monthly figures on premium motor fuel manufacture (PAW Form 48), separate figures shall be reported for any premium motor fuel manufactured and delivered for direct military uses in equipment owned and operated by the Army or Navy."

Confusion Corrected

Discussing the amendment, PAW Ickes said:

"As a result of this action, refiners will be able to manufacture a slightly larger quantity of premium motor fuel than was permitted during December. However, this does not mean that civilian motorists will be able to obtain additional quantities of premium gasoline, as the total increase granted by the amendment is not expected to exceed 60,000 barrels a day for the entire country. It is intended that most of the increase will be consumed by essential vehicles."

Issuance of WPB's revised lead limitation Order M-38 on Dec. 26, which seemed to tighten restrictions on use of tetraethyl lead, caused some confusion in the industry, it was reported, in view of the fact that PAW at the same time was allowing refiners to increase their output of premium for civilians.

The WPB explanation of the order stated: "Officials expect that the newly imposed restrictions will effect a 15% to 20% reduction in over-all lead consumption from the 1944 level to bring it in line with expected supplies," and this was reported as the cause for industry confusion.

A PAW official justified the apparent discrepancy between WPB's new M-38 and PAW's increase in civilian premium yields, explaining that while the WPB order limits the use of tetraethyl lead for other than the military to 30% of the weight of lead used by refiners during the first six months of 1944, there was no curtailment of civilian premium production—or lead consumption by refiners during that period.

Therefore, in using the first half of 1944 as a basis for current lead consumption, WPB has, in effect, allowed sufficient Ethyl fluid for the increase in premium for civilians permitted by Amendment 3 to PDO 21.

PAW Shifts Part of 'Gas' for U. K. Demands To Dist. 2, Stepping Up 80-Octane in Dist. 3

NPN News Bureau

WASHINGTON—Decision has been officially made by PAW to shift the burden of supplying between 35,000 and 40,000 b/d of 72-octane for United Kingdom on-shore military and civilian use from Dist. 3 to Dist. 2, thereby enabling Dist. 3 refiners to step up manufacture of 80-octane in line with recently increased military requirements. (*See NPN Dec. 27, p. 9*)

Shift in the supply source will require diversion of about 30,000 b/d of tank car capacity from Dist. 3-East Coast kerosine and distillate service, and is made possible by the fact that the military has agreed, NPN was told, to make up the rail deficiency by providing tanker tonnage sufficient to maintain scheduled heating oil deliveries to Dist. 1.

PAW had insisted on release of the tankers before consenting to transfer of tank cars to 72-octane service from Dist. 2.

Even with tankers available, however, PAW looks for development of an "awfully tight" situation with respect to distillate before the end of the current heating season. This is because of inability of refiners to provide as much of the lighter fuels as is required, largely due to the fact that cat crackers are chewing up larger quantities of distillate, plus continued heavy demand for Navy Special and other products.

As to the effect the shift of 35,000 to 40,000 b/d of 72-octane demand will have on Dist. 2, PAW concedes this will interfere seriously with winter build-up of stocks against the spring planting demand.

It is PAW's intention, however, to keep close tab on actual military consumption and to cut back scheduled shipments later if it is found that requirements do not come up to present expectations of the military. In this way, it may be possible to avoid a situation which, on paper at least, would find Dist. 2 gasoline stocks at distress levels by mid-year.

Recent Patents

REFINING

Catalytic conversion of hydrocarbons. Louis S. Kassel, Chicago, Ill., assignor to Universal Oil Products Co. Filed April 29, 1940. No. 2,360,349.

Manufacture of ethyl benzene. William J. Mattox, Chicago, Ill., assignor to Universal Oil Products Co. Filed Feb. 11, 1942. No. 2,360,358.

Hydrofluoric alkylation of paraffins. Maryan P. Matuszak, Bartlesville, Okla., assignor to Phillips Petroleum Co. Filed June 2, 1941. No. 2,360,436.

Hydrocarbon conversion. Maurice H. Aveson, Flossmoor, Ill., assignor to Standard Oil Co. (Ind.) Filed April 24, 1941. No. 2,360,463.

Method of removing mercaptans from hydrocarbon oil. George W. Ayers, Chicago, and Lawrence M. Henderson, Winnetka, Ill., assignors to Pure Oil Co. Filed March 17, 1943. No. 2,360,537.

Alkylation process. Joseph A. Chenicek, Riverside, Ill., assignor to Universal Oil Products Co. Filed Oct. 29, 1943. No. 2,360,547.

Conversion of hydrocarbons, and treatment of hydrocarbons. Gustav Egloff, Chicago, Ill., assignor to Universal Oil Products Co. Filed June 7, 1940. Nos. 2,360,553 and 2,360,552. (2 patents).

Method of producing aviation gasoline. Bruno E. Roetheli, Cranford, N. J., assignor to Standard Oil Development Co. Filed April 30, 1943. No. 2,360,622.

Distillation process. Richard M. Deansly, Berkeley, Calif., assignor to Shell Development Co. Filed Feb. 24, 1940. No. 2,360,655.

Process for dehydrogenation of gaseous and liquid petroleum hydrocarbons. Herman B. Kipper, Accord, Mass. Filed Nov. 4, 1942. No. 2,360,689.

Catalytic conversion processes. Sumner H. McAllister, Lafayette, and John Anderson and William E. Ross, Berkeley, Calif., assignors to Shell Development Co. Filed July 25 and Aug. 2, 1941. (2 patents) Nos. 2,360,699 and 2,360,700.

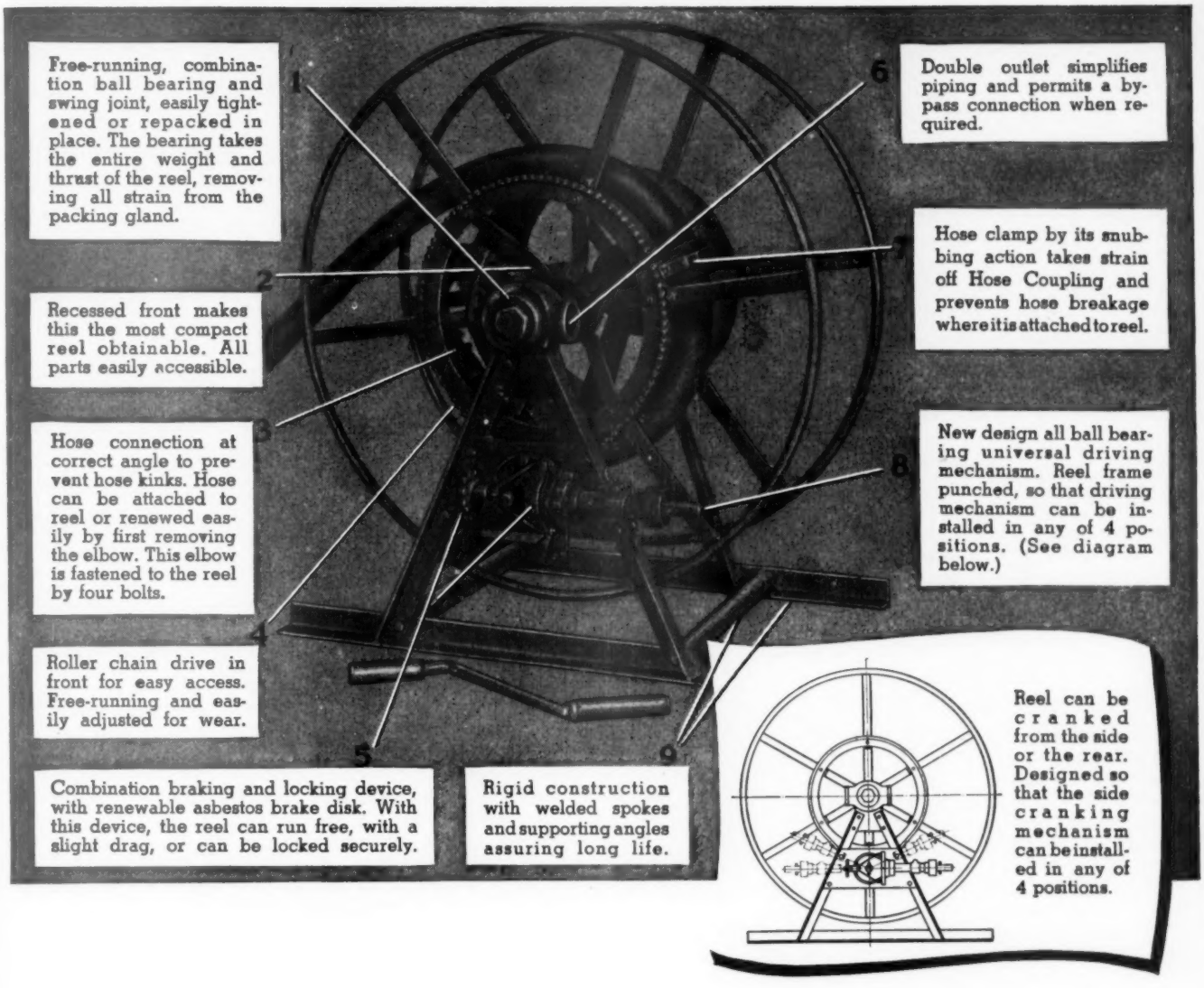
Chemical process. Eger V. Murphree and Charles W. Tyson, Summit, Donald L. Campbell, Short Hills, and Homer Z. Martin, Elizabeth, N. J., assignors to Standard Catalytic Co. Filed Dec. 27, 1940. No. 2,360,787.

MISCELLANEOUS

Method of producing plasticizing agents from acid sludge. Robert P. Ferguson, Cranford, N. J., assignor to Standard Oil Development Co. Filed May 24, 1941. No. 2,360,320.

Lubricants. Robert D. Herlocker, Hammond, and Milton P. Kleinholz, East Chicago, Ind., and Franklin M. Watkins, Chicago, Ill., assignors to Sinclair Refining Co. Filed April 24, 1943. (two patents) Nos. 2,360,323 and 2,360,324.

Compiled by R. E. Burnham, patent and trade-mark attorney, 511 11th Street, NW, Washington 4, D. C., from whom copies may be obtained at rate of 25c each. State number of patent and name of inventor when ordering.


1
Free-running, combination ball bearing and swing joint, easily tightened or repacked in place. The bearing takes the entire weight and thrust of the reel, removing all strain from the packing gland.
2
Recessed front makes this the most compact reel obtainable. All parts easily accessible.
3
Hose connection at correct angle to prevent hose kinks. Hose can be attached to reel or renewed easily by first removing the elbow. This elbow is fastened to the reel by four bolts.
4
Roller chain drive in front for easy access. Free-running and easily adjusted for wear.
5
Combination braking and locking device, with renewable asbestos brake disk. With this device, the reel can run free, with a slight drag, or can be locked securely.
9
Rigid construction with welded spokes and supporting angles assuring long life.
6
Double outlet simplifies piping and permits a by-pass connection when required.
7
Hose clamp by its snubbing action takes strain off Hose Coupling and prevents hose breakage where it is attached to reel.
8
New design all ball bearing universal driving mechanism. Reel frame punched, so that driving mechanism can be installed in any of 4 positions. (See diagram below.)
Reel can be cranked from the side or the rear. Designed so that the side cranking mechanism can be installed in any of 4 positions.

The New Hose Reel You Have Been Looking For

COMPACT, RUGGED, LIGHT IN WEIGHT, BALL BEARING CONSTRUCTION THROUGHOUT

The new Philadelphia Valve Co. reel is the finest reel built. It is compact, rugged, and light in weight. All parts are of steel, malleable iron, or bronze; no cast iron is used. It is ball bearing throughout with hardened and ground races. (6 ball bearings are used.) It will never wear out.

The reel can be changed from top winding to bottom winding by reversing the hose connection and rotating the drum. All working parts and hose connections are in front and easily accessible. It is light in weight, a reel that holds 100 feet of 1½" hose, only weighs 93 pounds.

We can furnish hose reels in any size or shape. They can be furnished for installation either in bucket box at rear of truck or in underslung box on side of truck. Give inside dimensions of box when writing for information. Special reels can also be furnished for Airfield Refueling Pits and Ship Docks.

Delivery can generally be made in a few days after receipt of order. For sizes, prices, and dimensions, write for Catalogue No. 165.

PHILADELPHIA VALVE COMPANY

ARAMINGO AVENUE AND ONTARIO STREET, PHILADELPHIA 34, PA.

Pacific Coast Distributor: Oil Marketing Equipment Co., 325 Fremont St., San Francisco, Cal.

Goodrich Official Reports Hawaii Is Growing Rubber

HONOLULU — Hawaii is currently producing natural rubber, N. F. Weber, former Akron resident, manager of the B. F. Goodrich International division here, recently reported to his company. Mr. Weber recently airmailed a sample smoked sheet of the Hawaiian rubber to Akron. This is the only tree rubber being grown in American territory, except for experimental plantings in Florida.

Progress Mfg. Co. Wins 'E'

ARTHUR, Ill.—Award ceremonies will be held Jan. 10, when the Oil Equipment Division of the Progress Mfg. Co. of this city will be awarded the Army-Navy "E" for excellence in war production.

ICC Authorizes Another Full Year of Activity By Southern States Oil Hauling Co-operative

Special to NPN

SPARTANBURG, S. C.—Backed by the support of the Army Air Forces and twelve major petroleum companies, the application of the War Emergency Co-operative Association of Spartanburg, S. C., for permission to extend its authority for another full year has been granted by the Interstate Commerce Commission.

L. A. Odom of Spartanburg, president and attorney for the co-operative, said the extension covered the period from Jan. 1, 1945 until next December 31. Under terms of the association's authority, bulk transportation of petroleum products by transport trucks is covered between points and places in the Carolinas, Georgia and Florida.

In addition to the Army Air Forces, the following shippers lent support to the association's application for extension of its authority:

Gulf Oil corporation, The Texas Co., Standard Oil Co. of Kentucky, Sinclair Oil Co., Arkansas Fuel Oil Co., Shell Oil Co., American Oil Co., Pure Oil Co., Republic Oil Co., Southeastern Oil Co., Wofford Oil Co. and Crown Central Petroleum Corp.

Extension of the authority, it was said, was opposed by the Walker Hauling Co. and the Russell Transfer Co. of Georgia and by Beard-Laney, Inc., Southern Transportation, Inc., Vaughan's Transfer and others in South Carolina.

In connection with the announcement concerning extension of the association's authority, Mr. Odom revealed that the cooperative is now operating approximately 200 trucks, serving 20 air fields in Georgia and the Carolinas—as well as several hundred bulk plants in the same states.

Serves All of Southeast

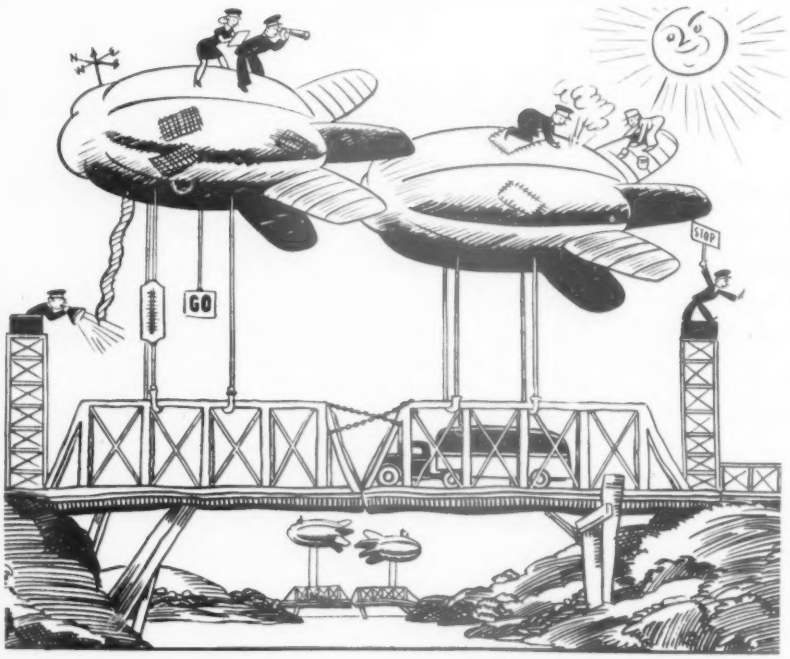
Services of the concern, he added, are being utilized by every major petroleum products shipper in the Southeast.

Latest figures of the association show that during the last 90-day period a total of more than 128,000,000 gallons of petroleum was hauled by trucks of the organization—or more than 1¼ million gallons daily.

Directors of the association are Mr. Odom, Roy Abernathy of Asheville, N. C.; J. A. Hall of Macon, Ga.; W. C. Hamrick, Jr., of Gaffney, S. C.; G. L. Hughes of Spartanburg, S. C.; D. W. Royster of Shelby, N. C.; L. L. Echols of Greenville, S. C.; F. M. Skinner of Waynesboro, Ga. R. E. Littlejohn, Jr. of Spartanburg is general manager of the association.

General offices are maintained in Spartanburg.

Old Barrage Balloons Answer Weak Bridge Problem



Well, well, look whoz back! Ike Doodleschmaltz, himself. Happy over seeing his recent contribution—"The Postwar Trailer to Fit All State Laws"—(NPN July 19, 1944, p. 32) he has submitted another idea, this time a postwar use for barrage balloons. In sending this to the Fruehauf Trailer Co, Ike explained that it was "the answer to the problem of 'weak bridge spans' on our main national highways."

Tank Car Demurrage Charges Ordered To Start Jan. 15

NPN News Bureau

WASHINGTON—At the request of ODT, ICC this week ordered demurrage charges on tank cars of $5.50, $11, and $22 for the first, second, and third day, respectively, that a tank car is held loaded on any track after 24 hours free time.

The demurrage charges apply:

(1) To tank cars actually placed and held for unloading;

(2) To tank cars constructively placed (but not actually placed) and held for loading, unloading or any other purpose; and

(3) To tank cars actually placed and held for loading or any other purpose.

ICC said that "constructive placement" means "the placement of, or holding of, a tank car on any track on account of the inability of the consignee or consignor to receive actual placement of such tank car or because of any other condition attributable to the consignee or consignor preventing actual placement of such tank car."

The ICC order, taken in Part 95—Car Service—Service Order No. 263, is effective Jan. 15 and expires March 1, unless otherwise ordered by the commission.

How BIG is a SMALL Cat-Cracker?

THE ISSUE which all refiners must squarely face in postwar competition is the production of high-octane motor fuels.

By and large, this calls for installation of *fluid* catalytic-cracking equipment. Even small operations can effectively utilize this process. For Kellogg is currently designing units with capacities varying from 1,760 to 35,000 bbls. per day.

Of utmost importance to refining-engineering economics . . . the smaller *fluid* Cat-Crackers equal the largest Kellogg-built plants in performance. But what about costs in ratio to size on a per bbl. of feed basis? Moderate sized units, with only half the capacity of today's giant war-developed "cats," can be built at costs which compare very favorably with those of the largest crackers now on stream. The increase in costs for even smaller units is surprisingly low. And, too, even the smallest units possess the same flexibility in handling various types of feed.

But like any refinery investment, the net profit to the customer is a matter of its economic evaluation in relation to existing facilities. Microscopic scrutiny of the pertinent facts is the first consideration. This is a job for M. W. Kellogg's Economics Consultation Service—an invaluable safeguard to capital investments.

THE M. W. KELLOGG COMPANY

★Only Kellogg Service Has Them All

★ **LABORATORIES**—fully equipped and staffed—devoted exclusively to chemical engineering and process development.

★ **24-HOUR-A-DAY PILOT PLANTS**—17 refining processes operating continuously—providing accurate data for commercial scale application.

★ **EXCLUSIVE CHEMICAL ENGINEERING DATA**—Continuously compiled . . . embracing both pilot plant runs and the operation of Kellogg-built refineries. Data extends from beginning of modern refining.

★ **PROCESS ENGINEERS**—Specialists who have continuously made major contributions to oil refining development, for more than 20 years . . . currently exemplified by their work on fluid catalytic-cracking.

★ **MECHANICAL ENGINEERS**—Kellogg installations—worth hundreds of millions—are their best reference.

★ **METALLURGICAL LABORATORY**—Establishes continuous check of specifications...creates new techniques for the fabrication of refining equipment.

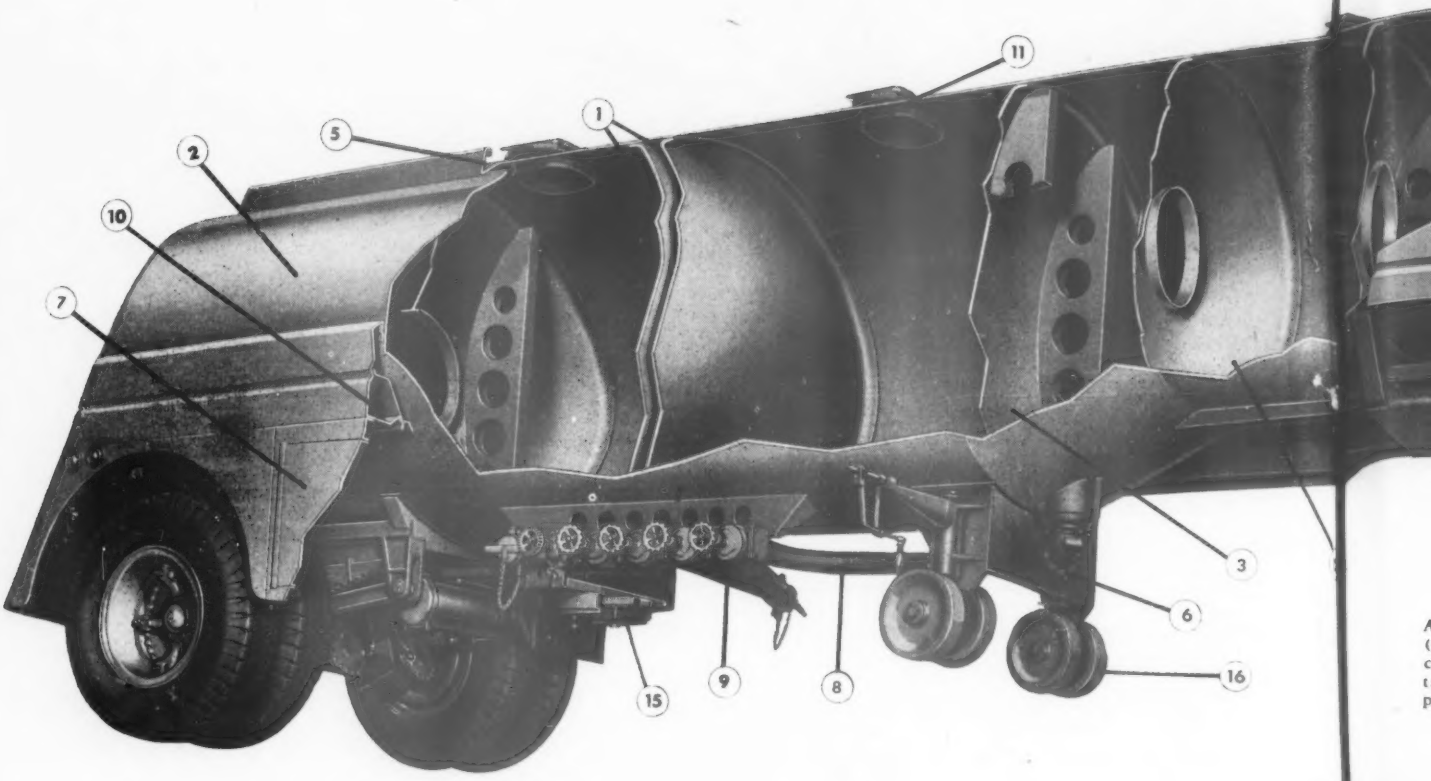
★ **PERMANENT CONSTRUCTION CREWS**—Geared to function all over the world on single units or multiphase refineries . . . team-experience cuts costs, speeds construction.

★ **OPERATING STAFFS**—Specialists at placing new units "on stream"... training of refiner's own operating crews.

★ **LICENSING SERVICE**—Licenses available through Kellogg as Licensor or licensing agent for all types of refining processes.

★ **ECONOMICS CONSULTATION**—Offers oil companies the opportunity to have their overall operations reviewed and evaluated by personnel with authoritative and extended experience in the field of petroleum economics and management.

225 Broadway, New York 7, N. Y. • Jersey City, N. J. • 809 South Grand Ave., Los Angeles, Calif. • Phillcoer Bldg., Tulsa, Okla. • 402 Esperson Building, Houston 2, Texas • Stone House, Bishopsgate, London, EC2



Heil "Trailerized" T

are engineered to give you increased hau

When you haul with Heil Trailerized Tanks, you enjoy bigger profits because of 5 "easy-to-understand" reasons. (1) GREATER PAYLOAD is provided, without increasing gross weight, through the elimination of unnecessary frame and reinforcing members required on ordinary tank trailers. (2) LOWER COST PER GALLON results from increased payload per trip, lower operating cost per trip, and more trips per month. The simplified Heil design eliminates most common sources of trouble, resulting in low maintenance costs. (3) SAFE OPERATION and EASY PULLING are established by a low center of gravity which reduces sidesway and wind resistance. Rigid upper fifth wheel steadies the load and eliminates rocking and rolling on the curves. (4) QUICK, INEXPENSIVE REPAIRS are a money-saving feature of every Heil Trailerized Tank. Inside welds simplify tank repairs which can be easily made from the inside without the long, expensive job of removing hose tubes, tie bands, piping, frame and running gear members to make repairs. (5) ONE RESPONSI-

BIL for tan
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Experienced b
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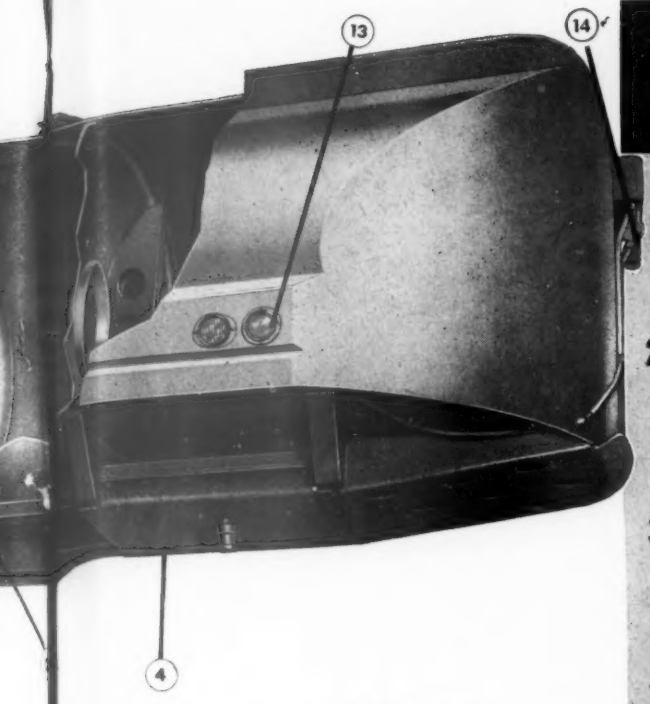
pro by doing

THE HEIL CO.

GENERAL OFFICES • MILWAUKEE 1, WISCONSIN



A cut-away view of a Heil Trailerized (frameless) Tank revealing the scientific construction and highly engineered details that explain why you get greater payloads plus dependable performance.

Check these Features

1 **INSIDE WELDING.** All welds accessible from inside for quick, easy repair.

2 **SMOOTH SKIN CONSTRUCTION.** Lengthwise wrapper sheets eliminate tie bands and give tank smooth, clean-cut appearance.

3 **DEEP DISHED HEADS.** Heads are flanged and reinforced to withstand surge and properly carry load stresses.

4 **RIGID UPPER FIFTH WHEEL PLATE.** This is the safest, simplest fifth wheel in use today. Any tendency to roll or sway is immediately absorbed by tractor and tank springs.

5 **SAFETY CATWALK.** Entire top of tank formed by non-slip tread catwalk with flashing on both sides to prevent spillage from defacing sides of tank.

6 **EMERGENCY VALVES.** Emergency valves to meet ICC requirements installed in each compartment.

7 **EMERGENCY VALVE CONTROL.** Individual cable type valve controls with fusible link which automatically closes valves in case of fire.

8 **STEEL TUBING.** All piping and manifolds made of rugged thin wall steel tube with large radius bends. Tubing installed with flanges and gaskets which simplify replacement.

9 **CROSS VALVES.** Quick acting valves manifolded on curb side next to emergency valve operator for convenient unloading.

10 **HOSE CARRIERS.** Weatherproof side hose tubes also act as side rub rails and add to the smooth, distinctive lines of Heil Trailerized Tanks.

11 **MANHOLE COVERS.** The most widely used manhole covers in the world today . . . Heil cast covers with built-in feather type vacuum relief valves and automatic pressure relief feature.

12 **DEEP DISHED SURGE PLATES.** Reduce load surge and splash as well as increase structural strength of the tank.

13 **LIGHTS.** ICC lights including turn signals and triple light cluster. All wiring in waterproof metal conduit with junction boxes at connection.

14 **BRAKE AND LIGHT CONNECTIONS.** Located in junction box on nose near top of the tank for easy accessibility. Keeps cable off tractor frame and prolongs life of cables.

15 **SPARE TIRE CARRIER.** Winch type spare tire carrier standard equipment. Tire quickly removed or installed in carrier.

16 **LANDING GEAR.** Popular screw type landing gear or a light weight retractable gear available on all Heil Trailerized Tanks.

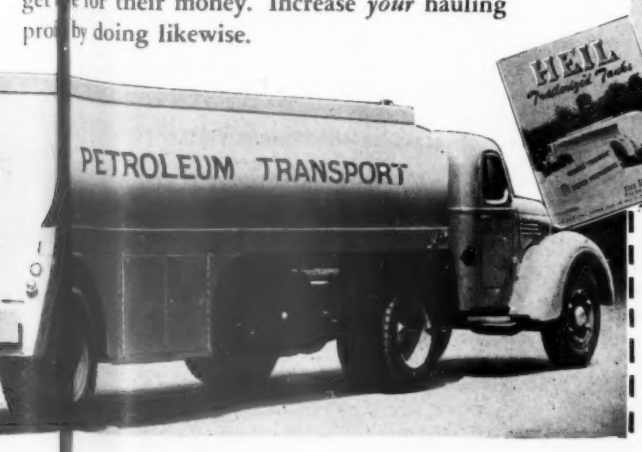
T-125

Tanks

edhauling profits

BIL for tank and running gear eliminates "bu passing between tank and running gear ma cturers. The Heil Co. backs up the entire uni m one end to the other, without reservation.

E ienced bulk haulers are standardizing on Hei ailerized (frameless) Tanks because they get e for their money. Increase *your* hauling pro by doing likewise.



Mail Coupon for Illustrated Bulletin TT4403

THE HEIL CO., Milwaukee 1, Wisconsin

Please send me Bulletin TT4403 on Trailerized Tanks.

Name ..... Position .....

Company .....

Address .....

City ..... ( ) State .....

Rail Hauls to East Decline to 502,868 b/d

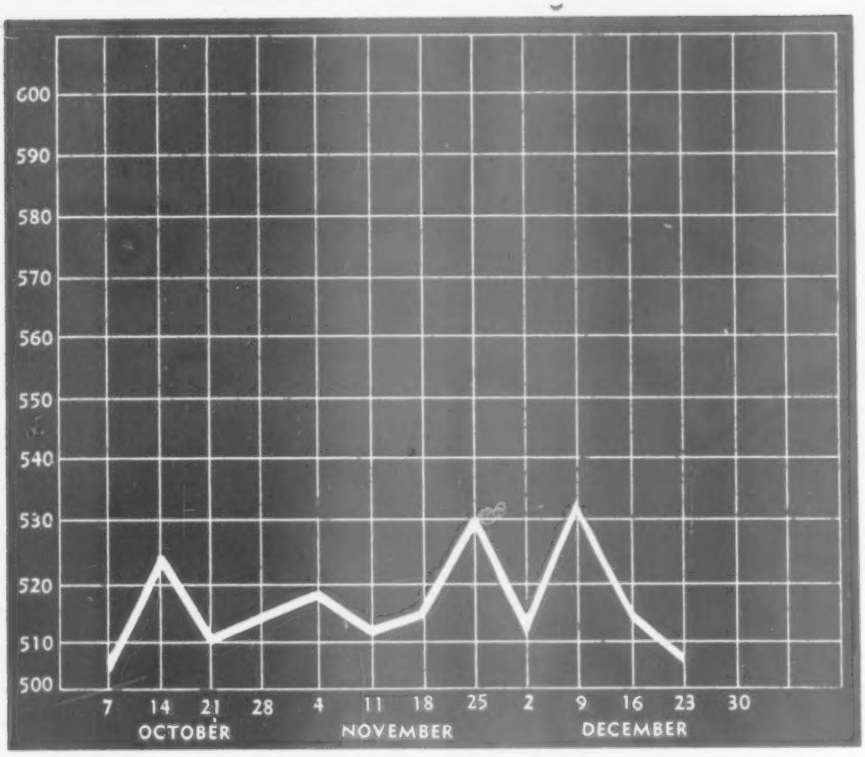


Chart shows average weekly tank car shipments to east in thousands b/d

NPN News Bureau

WASHINGTON—Tank car shipments to Dist. 1 averaged only 502,868 b/d during week ended Dec. 23, or nearly 90,000 b/d under level estimated by the year end.

This is lowest movement for any single week since March 21, 1942, when shipments averaged 464,561 b/d. In the week ended Oct. 7, movements were at a rate of 504,791 b/d but have held above that level ever since. During the week of Dec. 16 they averaged 514,499 b/d.

Last week's drop was attributed to severe winter weather, particularly in New York state, which has slowed turn-around time; to deteriorated condition of cars, and to congested holiday rail traffic.

Latest available figures also show a decline in rail movement to Dist. 5, shipments during week ended Dec. 2 averaging 114,024 b/d comparing with a previous high of about 138,000 b/d and a schedule movement of around 132,000 b/d. Last count showed 13,075 cars in service to west coast. Hauls to Dist. 1 were made by companies as follows:

Aetna	20	Franklin	3	Republic	74
Allied	27	Freedom Oil	2	Richfield	70
Amsco	113	Globe	154	Roosevelt Oil	7
Arkansas Fuel	150	Gulf	1933	Root	27
Ashland Refining	107	Hartol	297	Royal Petroleum	20
Asiatic Petroleum	9	Hess, Inc.	76	Shell	612
Atlantic Refining	785	Home Oil	25	Sinclair	778
James B. Berry Sons	13	Independent	84	Socony-Vacuum	1854
Cantelou	33	Industrial Oil & Gas	1	Southland	1
Chalmette	19	Jenny Mfg. Co.	113	S. O. Indiana	574
Champlin	119	Libby	1	S. O. Kentucky	69
Cities Service	370	Maritime Oil	12	S. O. New Jersey	2782
Coastal	16	National Refining	39	S. O. Ohio	241
Continental	56	Ohio Oil	17	Sterling	31
Cooperative Refining	25	Pacific	44	Sun	1434
Cosden	69	Pan American	849	Talco	2
Crown	42	Petroleum Heat & Power	38	Texaco	1377
Danciger	57	Phillips	151	Tide Water	128
Daugherty	12	Pioneer	1	Tiona	2
Drake	8	Premier	11	Triangle	34
Eastern	33	Primrose	35	White Fuel	63
Elk Refining	14	Pure	182		

Tanker Personnel Cited By Admiral Nimitz

NPN News Bureau

CLEVELAND—The officers and crew of the American tanker La Placentia won an official citation by Adm. Chester W. Nimitz, commander in chief of the U. S. Pacific Fleet and Pacific Ocean Areas, the War Shipping Administration announced last week.

The merchant officers and crew were cited for the "excellent service and outstanding co-operation" they gave the Navy in the conquest of the Marshall Islands.

The communication from Adm. Nimitz said:

"The commander in chief, U. S. Pacific Fleet and Pacific Ocean Areas has been informed of the excellent service and outstanding co-operation rendered by the officers and crew of the SS La Placentia at Majuro during the Marshall Islands operations.

"Officers and crew of the SS La Placentia stood by to give prompt and efficient action to all vessels requiring their service regardless of the time of day or long hours at station.

"The commander in chief, U. S. Pacific Fleet and Pacific Ocean Areas, desires to commend the officers and crew of the SS La Placentia for the active spirit of co-operation evidenced by their earnest desire to extend the service facilities available to the utmost extent."

The cited tanker, 12,304 deadweight tons, was built at San Pedro, Calif., in 1921 and is owned by the Union Oil Co. of California. Time chartered to the War Shipping Administration, she is operated in war service by that company. The master of the vessel is Capt. Maurice V. Ring, Dillon, Mont.

Asks Nebraska Tax Law To Help Rural Roads

Special to NPN

OMAHA — Upstate legislators have hopes of again amending Nebraska's gasoline tax law in order to return more tax money to rural counties for construction and maintenance of their roads, according to former State Senator Tony Asimus, who is an oil jobber at O'Neill.

Mr. Asimus served in the state legislature from 1941 to 1944, but said on a recent visit here that he had decided not to enter the race again this year, as business interests required his full time. He is a distributor of Champlin Refining Co. products and ran two transports for 13 years, until temporarily shut down last year by lack of help. Meantime he operates his bulk plant, two service stations, a grocery and hotel.

In 1942, while serving in the legislature, Mr. Asimus sponsored an amendment to the gasoline tax law, providing for allocation of tax money to counties on the basis of population. The old law distributed the money on a vehicle registration basis, which, the former legislator asserted gave Douglas County, in which Omaha is situated, and other similar big city areas, an unfair advantage. However, the sums provided in the Asimus amendment to the law were cut in half before passage by the legislature, and the "grass roots" legislators are now at work to secure benefits of the other half when the assembly meets again this month.

"My amendment," said Mr. Asimus, "is working out satisfactorily as we planned it. It benefits 35 out of 43 legislative districts in the state by giving them more tax money for road improvements, which money is taken from the remaining eight big city districts. But what we need is full benefit—not just half."

Prestige—

THE FRUIT OF SPECIALIZATION

More than 35 years devoted exclusively to the manufacture of spark plugs has given Champion a background of knowledge and experience that can be invaluable to the dealer seeking maximum spark plug turnover, volume and profits.

The fruit of this specialization is prestige that has given Champions sales leadership for many years past. And NOW their record of performance in airplanes of every type, in every theater of war, has brought added prestige to Champion Spark Plugs.

The public recognizes airplane performance as the acme of perfection. The prestige gained by Champion leadership in aviation, when added to the unequalled prestige Champions have gained in the passenger car field, in the farm field, in the truck, bus and marine fields, and in the racing field, puts Champions in a position of undisputed leadership.

The largest advertising campaign in Champion's history will celebrate this newest phase of Champion prestige, giving added emphasis and new impetus to the acceptance of Champions by the public.

Capitalize on the priceless asset of Champion prestige by having our factory representative or jobber salesman show you how and why Champion dealers enjoy unequalled volume and profit opportunities. Champion Spark Plug Company, Toledo 1, Ohio.

DEPENDABLE

CHAMPION

SPARK PLUGS

ARMY E NAVY

Buy More and More War Bonds Until the Day of Victory

FIRST OF A NEW SERIES OF NATIONAL MAGAZINE ADVERTISEMENTS FOR 1945

Reports on Recovery Record in Illinois

NPN News Bureau

CHICAGO — The Bureau of Mines in Washington has released its fifth report on secondary recovery methods used in various oil fields. The report covers 99 operations in the state of Illinois and gives details on how gas and air are injected into the wells to provide the necessary stimulus to drive reluctant oil from subsurface sands to the wells. The other four reports dealt with water flooding in Kansas, Oklahoma and Illinois, and with oil well reconditioning and air-gas injectors in the Appalachian region.

Production of some stripper wells in Illinois fields has been increased as much as 30% in recent years by forcing gas and air into the underground reservoirs and compelling the static oil to move, according to the Bureau of Mines survey released by Dr. R. R. Sayers, director.

32,000 Acres Affected

"Although gas was injected into oil sands in Ohio more than 40 years ago to stimulate production and increase the potential yield," Dr. Sayers said, "the process was not readily adopted in Illinois fields because most of the oil properties produced from sand formations subjected to vacuum, and operators were reluctant to use a method which might drive oil from their properties to adjacent vacuum-operated properties."

Gas injection recovery efforts did not begin in Illinois until about 1921, and since have been extended to more than 32,000 acres constituting the 99 projects, which were in operation as of July, 1943, the survey shows. The Robinson field in Crawford county offered the most favorable opportunities for profitable developments in older fields, although "the quantity of oil gained from these (Illinois) fields by (air and gas) projects which have been operating for nine or ten years is not spectacular when compared to results obtained by successful water flooding operations," it was explained by authors of the Bureau's summary, C. M. Keithly and Thomas Jennings, petroleum engineers of the Mines Bureau station at Bartlesville, Okla., and the Petroleum Field office at Franklin, Pa.

FPC Chief's Letter to Kansas Governor Disclaims Any Intention To 'Invade' State Rights on Gas

NPN News Bureau

WASHINGTON—The Federal Power Commission this week flatly denied that, in instituting its natural gas investigation, it has any desire to interfere with the several states in the full and effective exercise of their authority regarding either the production or local distribution of natural gas."

Statement as to FPC intentions, made in a letter to Kansas' Gov. Andrew F. Schoeppel, chairman of the Interstate Oil Compact Commission, was intended to eliminate "any misunderstandings" in oil and gas industry circles concerning the purpose of the commission's inquiry into the nation's natural gas resources.

Complete text of the letter, dated Dec. 30, and signed by Basil Manley, FPC chairman, follows:

"My Dear Governor Schoeppel:

"The representative of the Federal Power Commission who attended the recent Jackson, Miss., meeting of the Interstate Oil Compact Commission, in response to your kind invitation, advises us that there appears to be some misunderstanding regarding the investigation of certain phases of the natural gas industry which we recently ordered in Docket G-580. He indicated that these misunderstandings were being stimulated by representatives of gas and oil companies.

"We are therefore writing you, as chairman of the Interstate Oil Compact Commission, consisting of representatives of practically all the states producing natural gas, with a view to eliminating any misunderstandings concerning our purposes in instituting this investigation. Copies of this letter are being sent to the governors and other appropriate officials of the several states.

No Desire to 'Invade'

"First, we wish to assure the representatives of all the gas producing states that the Federal Power Commission has no desire to extend its jurisdiction to cover the production of natural gas or otherwise invade what are properly regarded as the functions of the conservation authorities of the several states.

"We recognize that the Congress, upon the recommendation of the President, has approved and repeatedly extended the Interstate Compact to Conserve Oil and Gas, dated Feb. 16, 1935. We are also aware of the progress which the states, co-operating through the medium of the Interstate Oil Compact Commission, have made in effectuating the will of the Congress, thus expressed, that waste and dissipation of the nation's irreplaceable resources of oil and gas should be prevented.

"It is our desire to aid the states in achieving this end in accordance with the provisions of section 11B of the Natural Gas Act which directs that . . . 'it shall be the duty of the commission to assemble and keep current pertinent information relative to the effect and operation of any compact between two or more states heretofore or hereafter approved by the Congress, to make such information public, and to report to the Congress, from time to time, the information so obtained, together with such recommendations as may appear to be appropriate or necessary to promote the purposes of such compact . . .'

'Conflicting Contentions'

"The immediate occasion for the institution by the commission of its investigation is that, in proceedings relating to the issuance of certificates of public convenience and necessity for natural gas pipelines, intervenors, including representatives of certain gas producing states, having contended that the commission is authorized and, under the provisions of the Natural Gas Act, should promote the conservation of natural gas by limiting or prohibiting its transportation and sale for certain so-called inferior end uses, such as boiler fuel. It has also been urged that the commission should deny certificates to take natural gas from states desiring to retain or utilize such gas within their own borders. With equal earnestness others insist that no restrictions should be placed upon the interstate transmission and sale of natural gas.

"In dealing with these conflicting contentions in individual cases it has become clear that the commission does not have sufficient information to formulate a definitive policy on its own part or to submit clear-cut recommendations to the Congress. We have accordingly instituted the investigation provided for in Docket G-580 not only as a means of developing the necessary facts, but also to give the gas producing and consuming states, as well as other interested parties, full opportuity to express their views.

"We have been gratified by the constructive suggestions received from several of the major gas producing states, in response to our invitation, and espe-

Ohio Oil 5000 Feet Down In Maryland Test Well

Special to NPN

SALISBURY, MD.—Ohio Oil Co.'s No. 1 Larry Hammond, six miles east here on the Eastern Shore, is now drilling below 5000 feet but no information other than as to depth has yet been released.

Ohio Oil has more than 200,000 acres under lease on the Eastern Shore and its No. 1 well is the first really comprehensive test of Atlantic seaboard oil prospects ever made north of Georgia. Company started making hole last August.

cially by the declaration contained in the statement filed by the corporation commission of your state: 'We welcome the opportunity presented for all parties thoroughly to air their views and we feel that from such investigation a great deal of good may come.'

"We wish, in closing, to assure you and all others who may be interested that, in instituting this investigation, the commission has no desire to interfere with the several states in the full and effective exercise of their authority regarding either the production or local distribution of natural gas. The commission, of course, plans to utilize, as far as possible, the statistics and other information that have been accumulated by the various agencies of the states and of the Federal Government.

"All interested parties will be accorded a full hearing in order that we may, at the conclusion of the investigation, submit such a report as will, in the language of section 11-A of the Natural Gas Act, 'aid in the conservation of natural gas resources within the United States and in the orderly, equitable and economic production, transportation and distribution of natural gas.'

"Trusting that this statement will correct any misunderstanding which may have arisen as to the purposes of the commission in instituting this investigation, we are," etc.

• • •

FPC Sets Hearing on Proposed Texas Gas Line Into Mexico

NPN News Bureau

WASHINGTON — FPC will consider the application filed by Reynosa Pipeline Co., of Corpus Christi for authorization to export natural gas from Texas to the Republic of Mexico, at a public hearing on Feb. 8, at 10 a. m., at the commission's hearing room, Hurley Wright Bldg., Washington. The gas would be distributed in the city of Monterey and environs.

The applicant proposes to construct approximately 30 miles of 12¾-inch pipeline, extending southerly from a point in La Blanca Field, Hidalgo County, Texas, through the North and South Weslace fields in that county, and from there westerly to the American shore. At this point the new line would connect with about 3000 feet of 8⅝-inch parallel pipelines, extending across and underneath the Rio Grande to near Reynosa, and connecting there with a 14-inch transmission line of the Gas Industrial de Monterrey, S. A. to which Reynosa has agreed to sell and deliver up to 60,000 MCF of gas daily for distribution in the vicinity of Monterrey.

Interested state commissions may participate in the hearing, an FPC announcement stated.

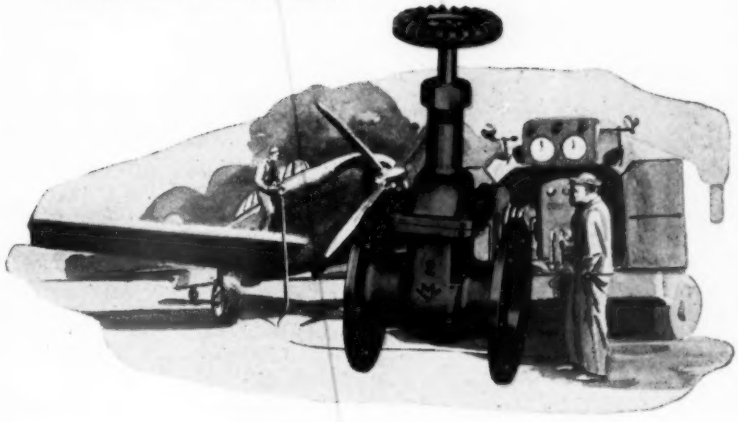
Californian Dies in Action

LOS ANGELES — **Sergt. Richard (Dick) Garrett,** who formerly was employed by the Superior Oil Co. in the oil fields near Coalinga, has been listed by Army authorities as killed in action.

SPEED AND RELIABILITY

Speed is a vital factor in readying our mighty bombbers and fighters for their all-important missions. And at army air bases all over the world, MILVACO valves and fittings are helping to feed the fuel that keeps 'em flying—saving precious minutes where time means most.

MILVACO valves and fittings are designed and engineered to provide a higher speed discharge in refueling operations—to maintain a smooth, constant, full and faster flow.



And this same precision workmanship, accuracy and unfailing dependability, now serving so many military uses, are embodied in MILVACO'S regular line of commercial valves and fittings for the petroleum industry which are now being produced for your more urgent needs.

MILWAUKEE VALVE CO.
MILWAUKEE, WISCONSIN

MILWAUKEE VALVE CO.

Rocky Mountain Oil & Gas Assn. Reactivated; Strong Program Mapped, Officers Elected

Special to NPN

CASPER, Wyo. — Revival of the Rocky Mountain Gas and Oil Assn. took place in Casper, Wyoming, recently, with representatives of all the major oil companies, independent operators, drilling contractors, independent land brokers, and affiliated industries from Wyoming, Colorado, Montana, and other nearby states activating the organization for the purpose of furthering the region's interests here and in the industry in general.

The newly elected officers are: President, Paul Stock, Independent, Cody, Wyo.; 1st Vice-President, Jimmy Donaghue, president of the Mackinney Oil & Drilling Co., Colorado Springs; 2nd Vice-President, A. B. Cobb, Independent, Great Falls, Mont.; treasurer, Fred Goodstein, president of the Trigood Oil Co., Casper, Wyo., and H. H. English, at present with the Continental Oil Co., Casper.

The chief purposes of the organization include securing methods of oil field development, establishing of scientific and research practices, inaugurating new ways of discovery, improvement of production, creation of effective conservation activities, and formation of a working legislative committee.

Busy Year Outlined

The next six to 12 months will see the group carrying out its organizational setup to the point where a full time staff will be necessary to handle their affairs. Permanent offices already have been selected in Casper, and the Executive Secretary, H. H. English, is working hard on preliminary details.

Another objective is to organize every possible phase of the oil industry in this region into one potent unit with each phase having full representation in the organization and a voice in its operation. Along these lines, every effort will be made to avoid the pitfalls of the earlier association by the imposition of sound and equal relationship among its members.

The original organization was headed by the late Bryant B. Brooks, former governor of Wyoming and long-time leader in many of Wyoming's industries. Mr. Brooks was an able business man and organizer but he was unable in recent years to devote much time to the organization. But that wasn't the main reason for the expiring of the old group, for, those companies which were active in the association were stymied by poor organization and the inclusion of too many interests.

Groups Function Individually

Under the new setup this has been eliminated. For example, the entire group of drillers in the association will function through an active representative or director and the same will apply to land brokers, sub-marginal independents and others. Thus, weighty, top heavy activity will not hinder the work of a small, but authoritative group.

After organization has been completed, the directors will work to develop markets for the crude oil of this region. This problem, large in scope, is expected to occupy a great deal of the organization's activities. The idea of markets not only includes selling of the product, but also "selling" the producers with the product.

The furthering of production methods will be fostered by application of proven means and the use of the latest types of equipment will be secured to benefit drilling operations.

Considerable interest has been shown in the development of shale in this area and the association has definite plans to join either with private or governmental agencies for further study. Also, study of conversion of the great undeveloped coal deposits in this area will be carried on, with the view that some day coal may be mined for oil production. Coal veins are readily accessible in this area, in most instances existing near the surface. Near Gillette, Wyo., veins average 90 feet in thickness.

The proposed legislative program will include action with the industry in the fight against importation of foreign oils. Oil men in this region think the foreign oil situation can be handled effectively over a longer period of time, with the least amount of abuse to the industry, if the situation is handled by the oil men themselves.

May Join Compact

The legislative committee will also study the Interstate Oil Compact with a view to joining or rejecting membership, and the findings will be made known as soon as determined. Most oil men in this region are "on the fence" in regard to the Compact and are eagerly waiting to get more details.

Any legislation—for or against the oil industry—will receive immediate attention of the legislative committee, and action will be taken accordingly.

In the near future Mr. English is going to visit the office of other oil associations for the purpose of co-ordinating activities, study administrative procedures, and make a general survey of operations. The Association will also contact PAW Ickes and present him an outline of some of the problems with which they are confronted.

Once the association is functioning smoothly, any new ideas about production, operations, costs, labor, handling, etc., will be pooled among the members for common use. This alone is expected to prove an invaluable factor when the needs of the growing industry is evaluated, and if these innovations prove their worth, they will be passed on to the entire industry.

A Word About the Officers

Mr. Paul Stock, President of the association, has been an Independent oil operator for 35 years in this area. His father was the discoverer of the Salt Creek Fields, the largest producing region in the Rocky Mountains. Mr. Stock first organized the old Stock Oil Co. in Cody some years ago and later the Yale Oil Co. of Billings which was recently purchased by the Carter Oil Co. He was formerly Mayor of Cody, Wyo., and is widely known for his civic and philanthropic activities. Also, he has devoted considerable attention to child welfare. At present his oil interests and royalties hold most of his attention.

Mr. Donaghue, first Vice-President, was a bell-hop before joining the Mackinney Oil Co., with whom he has worked many years. With this organization he was instrumental in the development of the Lance Creek Field in east central Wyoming. The history of Wyoming's oil development would be greatly lacking without the name of Mr. Donaghue, for his tireless efforts to better the industry have never slackened.

Mr. Cobb, 2nd Vice-President, developed the famous Cut Bank Field in

Probe Report Russ Removed Rumanian Machinery

NPN News Bureau

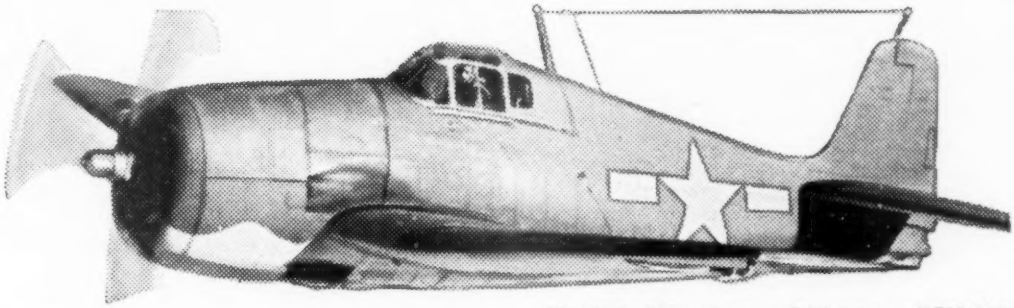
WASHINGTON — Removal by the Russians of certain oil field equipment from Rumania is being investigated by the U. S. and the British governments despite insistence by the Soviets that equipment taken was German.

Inquiry on behalf of the U. S. is being undertaken by Lieut. Col. H. Case Wilcox, representing the Army, and Ray Walters, recently named petroleum assistant to the American diplomatic adviser in Rumania who has long been active in that country with Jersey Standard's Romana-Americana Co. Col. Wilcox has had oil industry experience as a pipeline construction engineer.

Both American representatives either are already on the scene or enroute.

The question of removal first was raised in reports to State Department here, following which formal request was made to Russians to stop such action. The Russians replied, however, that equipment had been owned and installed by Germans and constituted legitimate spoils of war.

While investigation is being made, conservative opinion here is to the effect that it will bear out the Russian contention. One source expressed view that Reds "are as anxious as we are to maintain Rumanian production" at maximum possible levels, while another stated flatly that he doubted Russians had removed either American or British-owned equipment.



The Navy's F6F-5, latest model Grumman HELLCAT Fighter, in action with the Fleet in the Pacific

Phillips---with ever-increasing production of combat aviation gasoline, and recently expanded research facilities, confidently promises great postwar flying fuels---and greater gasolines for your postwar car

PHILLIPS VAST RESOURCES of raw materials . . . and Phillips long years of peacetime research . . . have not only made the company one of the nation's largest suppliers of 100-octane aviation gasoline, but have placed it among the top-ranking producers of butadiene for synthetic rubber. With today's ever-increasing emphasis on the chemical production of new and better things from petroleum, let the Phillips 66 Shield remind you that Phillips refineries, in addition to producing gasolines, lubricants, and fuel oils . . . are also *gigantic chemical plants* pouring out weapons for victory.

Car of the Future, designed by Martial & Scull, N.Y.

FOR VICTORY... Buy U.S. War Bonds and Stamps

➡ **THIS IS ONE** of a regular series of advertisements appearing in 425 leading mid-west newspapers on behalf of the Phillips Petroleum Company and its dealers.

northern Montana, near the Canadian border, and he still retains holdings there. He also built a refinery at Great Falls and worked on the development of the Lance Creek Field with the Minnelusa Oil Corp., which was eventually purchased by the Carter Oil Co. At present he has production in the Byron Field, Big Horn country, northern Wyoming.

Mr. Goodstein, treasurer, came to this area many years ago and started dealing in used oil equipment. Later he went into the supply business and founded the Trigood Oil Co., of which he is president. He also is president of the American Iron and Metal Co., with offices in Casper and a branch in Cut Bank. Another organization he controls is the American Pipe & Supply Co., Denver. Mr. Goodstein has production in Wyoming at North Fort Collins, Wellington Fields, Notches Dome, Salt Creek, Little Buffalo Basin, Natrona County, and South Elk Basin. In Montana, he holds interests at Cut Bank Field, Kervin-Sunburst Field, with extensive land and royalty interests in the surrounding territory.

English Veteran Oil Man

Mr. English, executive secretary, has had extensive experience in the oil business over a period of years. He started with Manning & Brown, drilling contractors at Waldron, Colo. Later he shifted to the Reed Roller Bit Co., and after that he worked as an engineer with the Eastman Oil Well Survey. He is now associated with the Continental Oil Co. as a land man and oil scout. As soon as it is practical, he will assume the position as full time Secretary.

Some of the major organizations in the Association are the Stanolind Oil & Gas Co.; Carter Oil Co.; Utah Refining Co., Salt Lake City, and the Wasatch Refining Co., Salt Lake City, subsidiaries of the Standard Oil Company of Indiana; California Oil Co., Independent; Argo Oil Co., Independent, Denver, Colo.

Mackinney Oil & Drilling Co., Colorado Springs, Colo.; Superior Oil Co. of California, with offices in Denver; Pioneer Oil Co., Denver; Gulf Oil Co., Denver; Shell Oil Co., Denver; Kinney-Coastal Oil Co., Denver; Union Oil Co., of California, with offices in Laramie, Wyo.; Amarado Oil Co., Ft. Collins, Wyo.; Mountain Fuel Supply Co., Rock Springs, Wyo.; Continental Oil Co., Denver; Barnsdall Oil Co., Denver; Tide Water Associated Oil Co., Sheridan, Wyo.; General Petroleum with offices in Casper; Sohio Oil Corp., Casper, Wyo.; Trigood Oil Co., Casper, Wyo.; British-American Oil Producing Co., Casper, Wyo.; Sinclair-Wyoming Oil Co., subsidiary of the Sinclair Oil Co., Casper.

Texas Co., Casper; Pacific-Western Oil Co., Casper; Atlantic Refining Co., Casper; Cities Service Oil Co., Casper; Pure-Oil Co., Billings; the Ohio Oil Co., Casper; Husky Refining Co., Cody; Mule Creek Oil Co., Billings; Bay Petroleum Co., Denver; Frontier Refining Co., Cheyenne; Phillips Petroleum Corp., Denver; Honolulu Oil Co., Cody; Kerlyn Oil Co., Casper; Kirk Oil Co., Frannie, Wyo.; Plymouth Oil Co., Casper.

The following members are drilling contractors: Manning & Brown, Inc., Denver; Loffland Bros., Tulsa; Parker Drilling Co., Tulsa, and Noble Drilling Corp., Tulsa.

National Foam Honored Again

Special to NPN

PHILADELPHIA — National Foam System, Inc., has been awarded its second star on its Army-Navy "E" pennant by the Navy Board for Production Awards.

Admiral C. C. Bloch, USN (Ret) announced the award as a result of the company's production in 1944 of highly specialized chemicals and apparatus for extinguishing fires aboard American combat vessels.

National Foam in peacetime supplies equipment and foam to extinguish petroleum and chemical plant fires.

Zook Maps Business for I.P.A.A. Session in Oklahoma City

NPN News Bureau

TULSA — The executive committee and state vice-presidents of the Independent Petroleum Assn. of America will be held at the Biltmore Hotel, Oklahoma City, on Jan. 29.

Ralph T. Zook, association president, in calling the meeting said that the need was urgent in view of the many recent developments pertaining to the domestic oil industry.

Most important items on the agenda are:

1. The developments and next steps in the crude price situation.

2. Revisions in the Anglo-American petroleum agreement.

3. The proposals of the National Planning Association regarding imports of oil.

4. Informing the new Congress on the problems of the domestic oil industry.

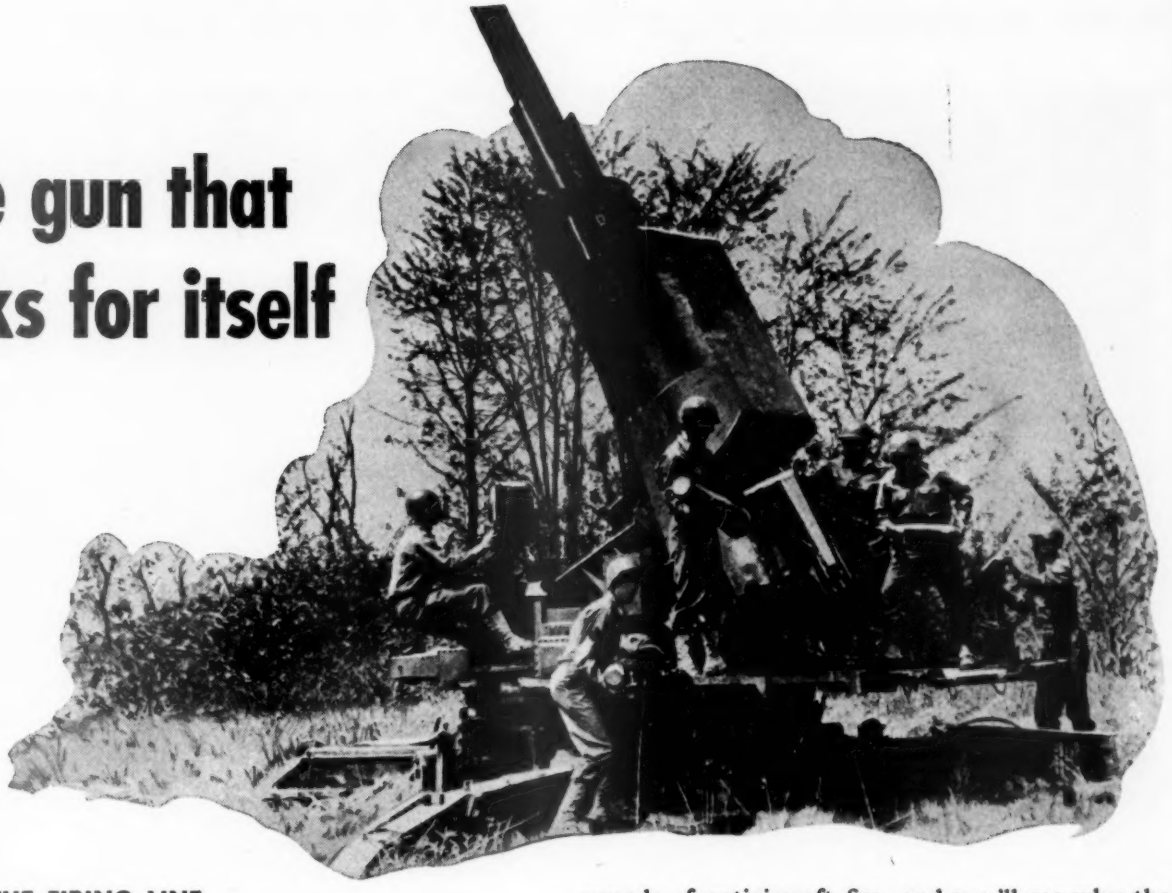
Representatives from all oil producing states are expected to attend.

Dealer and Service Station Gasoline Prices in 50 Representative U. S. Cities October 1, 1944

City	Dealers' Net Price (Ex. Tax)	Service Station (Ex. Tax)	Gasoline Tax (Inc. 1½ Cent) (Federal Tax)	Service Station (Inc. Tax)
Portland, Me.	10.8	4.0	5.5	20.3
Manchester, N. H.	11.8	4.1	5.5	21.4
Burlington, Vt.	11.4	4.0	5.5	20.9
Boston, Mass.	10.4	4.0	4.5	18.9
Providence, R. I.	10.5	4.2	4.5	19.2
Hartford, Conn.	11.1	4.0	4.5	19.6
Buffalo, N. Y.	10.1	4.2	5.5	19.8
New York, N. Y.	10.6	5.4	5.5	21.5
Newark, N. J.	10.2	5.0	4.5	19.7
Philadelphia, Pa.	10.2	4.2	5.5	19.9
Dover, Del.	10.7	4.3	5.5	20.5
Baltimore, Md.	9.95	4.05	5.5	19.5
Washington, D. C.	10.2	4.0	4.5	18.7
Charleston, W. Va.	11.65	4.05	6.5	22.2
Norfolk, Va.	10.45	5.55	6.5	22.5
Charlotte, N. C.	11.7	4.0	7.5	23.2
Charleston, S. C.	10.55	4.75	7.5	22.8
Atlanta, Ga.	11.1	4.0	7.5	22.6
Jacksonville, Fla.	10.1	4.0	8.5	22.6
Birmingham, Ala.	10.0	5.0	8.5	*23.5
Vicksburg, Miss.	9.5	5.0	7.5	22.0
Memphis, Tenn.	8.9	4.5	8.5	21.9
Lexington, Ky.	10.5	3.5	6.5	20.5
Youngstown, Ohio	9.5	3.0	5.5	18.0
South Bend, Ind.	10.5	4.5	5.5	20.5
Chicago, Ill.	9.6	2.76	4.5	16.86
Detroit, Mich.	9.9	3.74	4.5	18.14
Milwaukee, Wisc.	10.6	4.3	5.5	20.4
Twin Cities, Minn.	10.4	4.5	5.5	20.4
Fargo, N. Dak.	11.4	4.0	5.5	20.9
Huron, S. Dak.	10.8	3.7	5.5	20.0
Omaha, Neb.	9.6	3.0	6.5	19.1
Des Moines, Ia.	9.9	3.5	4.5	17.9
St. Louis, Mo.	9.5	3.0	4.5	*17.0
Wichita, Kans.	8.8	3.2	4.5	16.5
Tulsa, Okla.	8.0	3.0	7.0	18.0
Little Rock, Ark.	9.5	4.5	8.0	22.0
New Orleans, La.	8.75	4.75	8.5	22.0
Houston, Texas	8.5	4.5	5.5	18.5
Albuquerque, N. Mex.	10.5	4.5	7.0	**22.0
Denver, Colo.	10.0	4.0	5.5	19.5
Casper, Wyo.	11.5	5.0	5.5	22.0
Butte, Mont.	9.5	4.0	6.5	20.0
Boise, Idaho	13.5	4.0	6.6	24.1
Salt Lake City, Utah	13.5	4.5	5.5	23.5
Reno, Nev.	12.0	4.0	5.5	21.5
Phoenix, Ariz.	12.0	4.0	6.5	22.5
San Francisco, Calif.	10.0	4.0	4.5	18.5
Portland, Ore.	10.5	4.0	6.5	21.0
Spokane, Wash.	12.5	4.0	6.5	23.0

* Includes City Tax of 1.0. ** Includes City Tax of .50.

The gun that thinks for itself



ON THE FIRING LINE . . .

Firing only 22 rounds apiece, four American AA guns recently nipped 12 out of 16 attacking Jap bombers in the Southwest Pacific theater! An average of one plane for every 7⅓ shots!

Compare that with the World War I record of a hit . . . not necessarily a kill . . . for every 17,000 rounds of antiaircraft fire, and you'll see why the Army's mammoth 120 mm. antiaircraft gun is a weapon to be reckoned with!

And, considering the fact that the 120 mm. is so nearly automatic that about all its crew has to do is load and fire it, you'll see why it's called "the gun that thinks for itself!"

ON THE PRODUCTION LINE . . .

To make a gun that "thinks for itself" has kept a lot of people busy thinking ever since Pearl Harbor when the 120 mm. was still in infancy.

Not the least of these minds were recruited from the American Petroleum Industry. For it was this fighting industry's job to supply the cutting and quenching oils needed in the 120's manufacture . . . and the right lubricants to keep it operating safely in the field.

Needless to say, the Petroleum Industry acquitted itself well, and thus helped launch another ponderous and powerful weapon against America's enemies.

Gulf is indeed proud to be associated with the fighting Petroleum Industry!

GULF

READY TODAY WITH THE FUELS OF THE FUTURE

Store Modernization High On List of Dealers' Postwar Plans

This "open type" dealer store is one of several types being studied for possible recommendation to dealers for postwar operations. The fixtures in this type of design extend from inside of the room to a point that practically meets the window glass. Note the window platform instead of a bulkhead. This makes it possible to make the display serve a dual purpose—as a window and as an interior display

NPN News Bureau

CLEVELAND—More postwar planning of interest to marketing executives is seen in ideas for postwar use by Goodyear dealers being developed in the Goodyear's store planning and display department in Akron. This department now occupies 20,000 feet of space on top of the company's Goodyear Hall.

Termed the most extensive dealer help program in Goodyear history, a staff of display and merchandising men are working out a program which includes design for merchandising, fixture and equipment development, store planning and design, display materials, methods of pricing, interior displays, display promotion plans and display materials.

Particular stress is being placed on store layouts for dealers. The plan calls for a staff of merchandising engineers in the field who will work directly with the dealers.

These field merchandising engineers will make recommendations to the dealers, obtain sketches and layout from the department in Akron based on the engineers' suggestions, and if approved by the dealer, the merchandising engineer will supervise the actual installation, even to the arrangement of merchandise on the fixtures.

Goodyear now has approximately 36,000 dealers. J. E. Mayl, vice president and sales manager, tire division, says that numerous inquiries from dealers for complete store modernization have been received.

G.M. Posts $55,000 for Ideas On New-Type Dealer Quarters

Special to NPN

DETROIT — A further promise of stiffer rivalry between car dealers and service stations (*see NPN Nov. 22, p. 18*) is seen in the announcement by General Motors of an architectural competition for the design of automobile dealers' places of business in which $55,000 will be awarded.

Albert Bradley, G. M. executive vice president, said the competition was decided on after many dealers had indicated their postwar plans included enlarging or building new places of business.

The contest is under the direction of M. E. St. Aubin, director of the General Motors Service Section. It will be conducted by the *Architectural Forum* and governed by rules of the American Institute of Architects. It will run from Jan. 1 to April 16, 1945.

A total of 60 awards is offered. Five awards of $5000 each will be awarded for first place, and other smaller awards down to $250 each.

The competition is open to anyone except employes of General Motors and their advertising agents.

Tide Water Adds $50 War Bond For Employes in Service

NPN News Bureau

NEW YORK — An additional war bond of $50 maturity value will be presented to each of the approximately 1430 company men and women on leave of absence for military service from the Tide Water Associated Oil Co.

The company's directors voted to present this additional token during the Christmas season.

Other Tide Water benefits include an allowance upon enlistment of $200 in cash if married or $100 if unmarried; Series E war bonds of a face value of $150; a service credit equal to double the period of time spent in the armed forces in figuring retirement allowance for employes returning to the company and remaining until retirement; cancellation of any debts owed the company for petroleum products purchased through the company's credit courtesy cards; the payment by the company of one year's premium on government life insurance policies purchased by employes on military leave of absence and compensation for vacation if the employe received no vacation during the year of induction.

Equipment Personals

John C. (Josh) Billings is now in the truck and bus tire department of the B. F. Goodrich Co., **J. E. Powers,** department manager, announces. He had previously been in the tire requirements department.

* * *

Dr. Ronald E. Reitmeier has been appointed to the post of Director of Research and Development of the Gas Process Division of The Girdler Corp., Louisville, Ky.

Dr. Reitmeier

Dr. Reitmeier will have charge of the division's development program, designed to improve gas purification and manufacturing process.

Dr. Reitmeier, native of Spokane, Wash., joined Girdler in 1939. He obtained his Ph. D in chemistry at the University of Washington. He is a member of the American Chemical Society, Sigma Xi, and Phi Lambda Upsilon.

* * *

High recognition has come to **Harold W. Rehfeld,** B. F. Goodrich Co. tire technician, who has been named expert consultant to the Commanding General of the Army Service Forces in Europe, with headquarters in France.

In his new post, Mr. Rehfeld will advise the Army Service Forces on tire service and maintenance as well as the rubber manufacturers of Belgium and France on the use of synthetic rubbers and other raw materials.

Mr. Rehfeld, who has been production manager of the tread and calender room in the company's Akron tire division, joined Goodrich in 1929 as a chemist following graduation from the University of Minnesota. He is a native of Aberdeen, S. D.

* * *

H. L. (Hal) Lowry is the manager of the newly established Cleveland office of the Ladish Drop Forge Co., fittings division. The office will serve the state of Ohio, with headquarters in Mr. Lowry's offices in the Rockefeller Building.

* * *

Announcement has been made by Clark Bros. Co. of the opening of a new office, with other members of Dresser Industries, in the Chanin Bldg., New York City. **T. F. Hudgins** will be Export Manager in the new set-up. **R. R. McCartney,** who has been handling the Clark account in conjunction with **Val Wittich** for the past five years, is now the Clark district manager in New York.

Travel Days Will Be Back Again

BE READY

WITH A

Rotary

MEMPHIS

You will be ready for the increased post war business if you own a Rotary. Modern stations are choosing Rotarys for their speed of operation, their dependability, low maintenance cost, and because they meet all service requirements.

The Rotary Lift Company pioneered the auto lift and today has over 40,000 installations all over the world. This background of experience in building lifts means that your Rotary will be a mechanically perfect, highly developed piece of equipment.

Only a Rotary can give the combined advantages of:

- **AUTOMATIC AIR BLEEDER**
- **BABBITT-LINED STEEL BEARINGS**
- **SAFETY CONTROL VALVE**
- **THE HANDY TOOL SHELF**

ROTARY LIFT CO. — Memphis, Tenn.

SEND FOR NEW FREE CATALOGUE

ROTARY LIFT CO.
1064 Kentucky St., Memphis (2) Tenn.

Please Rush the New Rotary Catalogue No. 115.

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• ROTARY REPRESENTATIVES IN ALL KEY CITIES — — CANADA AND MEXICO •

Fields of Authority Are Now Well Defined Between ICC and Wages-Hours Division

By Elwin E. Hadlick

The Wages and Hours Law provides that the maximum hour provisions of the act shall not apply to any employer with respect to whom the Interstate Commerce Commission has power to establish qualifications and maximum hours of service pursuant to the provisions of Sect. 204 of the Motor Carrier Act of 1935. This exemption was the subject of much debate and in the early days it was not at all clear what rule employers should follow. The Wages and Hours Division had certain ideas and the Interstate Commerce Commission had other and conflicting ideas; then of course there were the impressions of the law entertained by the carriers themselves.

Mr. Hadlick

Doubts and conflicts have now been quite well settled. While the Administrator has no authority to extend or limit the scope of the exemption, nor even to force his interpretation, he has nevertheless proceeded to publish an interpretative bulletin setting forth his views, which governs his employes in their administration of the act. The publication is Interpretative Bulletin No. 9, and a copy can be obtained from any Wages and Hours office. This bulletin is "must" reading for any employer who feels that he may have any employes who come within the exemption.

Court Limits Jurisdiction

It is obvious that drivers of common, contract and private carriers engaged in interstate and foreign commerce within the meaning of the Motor Carrier Act of 1935 will be considered exempt from the maximum hour provisions of the Wages and Hours Act by virtue of the exemption. The Interstate Commerce Commission was given the duty to regulate common and contract carriers in various respects, including maximum hours of service; it was given the authority to prescribe maximum hours for private carriers engaged in interstate commerce if it found a need therefor. The Commission has prescribed maximum hours of service for common, contract and private interstate commerce carriers.

As indicated, drivers now present no problem. Questions have been raised as to ordinary country tank wagon drivers. Exemptions may be available to such drivers under provisions heretofore discussed, but they do not come within the jurisdiction of the Interstate Commerce Commission unless engaged in interstate commerce within the terms of the Motor Carrier Act.

There also have been questions as to other employers of the type carriers who are subject to the Motor Carrier Act. The law does not prescribe the jurisdiction of the Interstate Commerce Commission by using the term "drivers"; the law says that the Commission has authority in those matters relating to safety of operation and equipment. The Supreme Court has held that the Commission's jurisdiction is limited to those employes whose activities affect the safety of operation of motor vehicles and are engaged in transportation in interstate commerce.

Time on Job a Factor

The Commission, in appropriate proceedings, determined that it had jurisdiction over mechanics, loaders and drivers' helpers, in additon to drivers. The Administrator on his own accord holds that the term "loaders" does not include "unloaders"; that "mechanics" do not include garage employes who merely oil, gas, grease or wash motor vehicles, or painters, carpenters or tarpaulin menders.

Elwin E. Hadlick, prominent Minneapolis attorney and oil mrketing executive, continues his discussion of the Wages and Hours Law in the accompanying article. his 42nd in the series on war-oil compliance regulations. This article probably will be the last on the wage-hour subject.

The Commission has not yet fixed maximum hours of service of all employes subject to its jurisdiction. There was, for a long time a contention on the part of the Administrator that the exemption did not apply until the Commission issued its regulations. The Supreme Court exploded this kind of thinking and held that the exemption from the Wages and Hours Act applied from the date that the Act was passed, even though the Commission did not until some later date issue its regulations.

There is one qualification to this exemption of employes who are engaged in occupations relating to safety of operation and equipment. That is the general restriction that these employes who are claimed to be exempt must spend the greater part of their time in the exempt activity. The Administrator holds that if the greater part of the employe's time is spent in nonexempt activities, such as producing, processing or manufacturing goods, warehouse or clerical work, or other type of work which does not affect safety of operation, the exemption does not apply.

Wage-Hour Law Is Broader

The key to the confusion over employes who may be exempt because subject to jurisdiction of the Interstate Commerce Commission is probably in the laws themselves. The Motor Carrier Act covers interstate commerce; on the other hand the Wages and Hours Law covers employes engaged in interstate commerce or in the production of goods for interstate commerce. That sentence has been written in the language of the Administrator, and it represents his views on the matter. In other words, the Wages and Hours Law is broader in its scope than is the Motor Carrier Act.

There are many other phases of the Wages and Hours Law which could be touched upon in articles such as this. On the other hand, any one with a specific problem must get down to the application of certain paragraphs of the law. It is believed that enough has been said to provide a broad outline of the attitude of the Administrator as to application of the law to the petroleum marketing industry. It might be well particularly to point out that there is a special interpretative bulletin which deals with the matter of determining the number of hours which an employe works. If it has not occurred to you that there is some room for disagreement on this subject, a reading of the bulletin will be illuminating.

It is our responsibility to point out the desirability of compliance with governmental regulations relating to the petroleum industry, and to be helpful in determining methods of compliance.

A Word of Caution

Nevertheless it seems important to add a word of caution to those who may assume that the interpretations of the Administrator do not square with common sense or sound construction of the words used by Congress. The Supreme Court has said that the interpretations of the Administrator, as expressed in his bulletins are entitled to great weight.

When one argues that the Administrator has read something into the law that Congress did not intend, even though he bases his argument on something some member of Congress told him, he must remember that Congress has had the opportunity for several years to correct the Administrator in any parts of his regulations where he misinterpreted the intention, and has not done so. Generally speaking the Courts, as would reasonable people, assume that Congress would have acted

if the Administrator went beyond or outside the scope of its intention.

The courts have also been quite generally in agreement that the Wages and Hours Law, being remedial legislation, should be construed broadly so as to accomplish its purposes. In the same vein of thinking, courts hold that the exemptions in the law should be narrowly defined.

Index of Week's War-Oil Orders

(Issued Dec. 23-30, 1944)

PAW—Petroleum Administration for War

PDO 21, Am. 3—Permitted production of premium motor fuels increased.

OPA—Office of Price Administration

GMPR, RSR 11, Am. 56—Leasing of certain transportation facilities exempt from price control.

MPR 88, Am. 23—Gasoline ceiling formulas clarified; t.w. gasoline and kerosine ceilings under Treasury Procurement supply contracts in Far West.

RMPR 165, RSSR 19, Region VIII Order G-4—Oil burner and stoker service charges in Portland, Ore. area.

RMPR 436, Am. 9—Old Ocean Field crude ceiling.

Order 35—Subsidies for certain stripper wells.

2nd Rev. SO 76—One price regulation for all of a supplier's services.

RO 1A, Am. 92—Tire transfers.

Rev. RO 11, Am. 40—Registered dealer statements.

La Crosse Order G-1—Reports required from La Crosse registered dealers.

Sioux Falls Order G-1—Reports from Sioux Falls registered dealers.

Green Bay Order G-1—Reports from Green Bay District registered dealers.

WPB—War Production Board

L-103-b as am. 12-22-44—Glass container and closure quotas.

M-300, Schedule 78—Carbon tetrachloride allocation.

Pri. Reg. 26—Penalties for non-compliance with WMC regulations.

FEA—Foreign Economic Administration

Gen. Licenses, Am. 270—Exports.

OWM—Office of War Mobilization

Deferment of Expiration of Temporary Maximum Passenger-Car Tire Price Increases—Dec. 15, 1944 expiration date extended to April 15, 1945.

ICC—Interstate Commerce Commission

Ex Parte Nos. MC-13, MC-3, 3666—Extension of effective period of 10-5-43 order through 12-31-45.

Dept. of the Interior—General Land Office

Gen. Land Office Circular 1589—Submission of full terms of assignments within 90 days.

CODE: AO—Administrative Order; CMP—Controlled Materials Plan; D—Directive; FDO—Food Distribution Order; GMPR—General Maximum Price Regulation; GO—General Order; Interp.—Interpretation; L—Limitation Order; M—Conservation Order; MPR—Maximum Price Regulation; P—Preference Rating Order; PAO—Petroleum Administrative Order; Pri. Reg.—Priorities Regulation; Proc. Reg.—Procedural Regulation; PS—Price Schedule; RO—Ration Order; RPS—Revised Price Schedule; SO—Supplementary Order; SR—Supplementary Regulation.

Digest of Week's War-Oil Orders

Petroleum Administration for War

PERMITTED PRODUCTION OF PREMIUM MOTOR FUELS INCREASED—PDO 21, Am. 3—(*See p. 3, Dec. 27, NPN.; also p. 26, this issue*).

Office of Price Administration

EXEMPTION OF CERTAIN TRANSPORTATION SERVICES FROM PRICE CONTROL—GMPR RSR 11, Am. 56—Leasing of trucks, trailers, semi-trailers, tugboats, towboats, barges, etc. by RFC, Rubber Reserve Co., Metals Reserve Co., DSC and Defense Plant Corp. exempted from price control. Issued 12-29, effective 1-3-45.

GASOLINE CEILING FORMULAS CLARIFIED—MPR 88, Am. 23—(*See p. 11, Dec. 27 NPN.*)

OIL BURNER AND STOKER SERVICE CHARGES IN PORTLAND, ORE. AREA—RMPR 165, RSSR 19, Region VIII Order G-4—Vancouver, Wash. and many towns in Oregon included in Portland City Area, where $2 charge for first hour and $1.50 for second and succeeding hours prevails, unless service supplier has filed higher price under RMPR 165, or a higher per-call rate. Issued 12-14, effective 12-16, filed 12-22.

OLD OCEAN FIELD, TEXAS, CRUDE CEILING—RMPR 436, Am. 9—$1.48 set for 40 deg. A.P.I. gravity crude and above, with 2c differential for each degree of gravity down to 20. $1.06 ceiling for gravities below 20 deg. Issued 12-27, effective 1-1-45.

SUBSIDIES FOR CERTAIN STRIPPER WELLS—RMPR 436, Order 35—(*See p. 36, Dec. 27 NPN.*)

ONE PRICE REGULATION FOR ALL OF A SUPPLIER'S SERVICES—2nd Rev. SO 76—Regional Administrators and authorized District Directors, in addition to the Price Administrator, may grant authorizations to use one price regulation for all of a supplier's services. Only the Price Administrator may make such authorization for person subject to MPR 134 (rental of construction equipment and services) or MPR 136 (machines and parts) when sales of services under either regulation during 1942 exceeded $75,000. Issued 12-26, effective 12-30.

TIRE TRANSFERS—RO 1A, Am. 92—Certificates for tires dated prior to 4-1-44 now invalid for all purposes, but manufacturer may transfer a tire (except truck tire of 8.25 or larger cross-section) on certificate received from a dealer before 7-16-44. Applicants for tires for commercial motor vehicles no longer need present to Boards a currently valid Certificate of War Necessity for such vehicles, but Board may ask for serial and class number of Certificate, to establish that one is outstanding for the vehicle in question. Issued 12-23, effective 12-27.

REGISTERED DEALER STATEMENTS—Rev. RO 11, Am. 40—(*See p. 13, Dec. 27 NPN.*)

REPORTS REQUIRED FROM LA CROSSE REGISTERED DEALERS—Rev. RO 11, La Crosse Order G-1—Registered dealers in the La Crosse, Wis. District, having a registered capacity between 250 and 999 gals., must file statement on OPA Form R-1198 by 1-25-45, as of 1st of month, and file similar reports every six months thereafter. Any excess ration evidences on hand must be surrendered at time of filing statement, with explanation. Issued 12-8, effective 12-24, filed 12-22.

REPORTS REQUIRED FROM REGISTERED DEALERS IN SIOUX FALLS, S. D., DISTRICT—Rev. RO 11, Sioux Falls Order G-1—Sioux Falls District registered dealers must comply with order identical with La Crosse order, *outlined above*. Issued 12-22, effective 12-27.

REPORTS REQUIRED FROM GREEN BAY DISTRICT DEALERS—Rev. RO 11, Green Bay Order G-1—Order identical with two outlined above issued for Green Bay District dealers. Issued 12-20, effective 12-31.

OIL-LAW-Gram Service

Complete texts of all orders or amendments digested in war-oil orders can be had from Platt's Oil-LAW-Gram, 1213 West 3rd street, Cleveland 13, Ohio. Minimum charge single copies $1. Copies of these texts are always in stock but large orders can be promptly filled by reprinting as plates and stencils are also kept.

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Due care and judgment have been taken in preparing and publishing these digests and in reproducing the original texts but the publisher does not warrant their absolute legal completeness nor accuracy. Important decisions by the reader should be made only after careful study of complete texts.

War Production Board

GLASS CONTAINER AND CLOSURE QUOTAS—L-103-b, as am. 12-22-44—Lubricating and machine oils packers and lighter fluid packers may use their 1944 quota of glass containers for 1945. Small user exception continues at $5000. In addition to packing products for which a quota has been assigned, packers other than small users may use in each of their plants a maximum of $5000 worth (cost) of glass containers to pack all classes of products for which they have no quota. Issued 12-22, effective 1-1-45.

CARBON TETRACHLORIDE ALLOCATION—M-330, Schedule 78—Listed as an Appendix B material. Persons ordering over 700 lbs. (one drum) of carbon tetrachloride per month in the aggregate from all suppliers must furnish certified statement of proposed use to each supplier. Special one-time reports to WPB provided for commercial dry cleaners. Their suppliers must file on Form WPB-2947 by 15th of month preceding delivery. Issued 12-22.

PENALTIES FOR NON-COMPLIANCE WITH WMC REGULATIONS—Pri. Reg. 26—Any priorities or allocations by WPB may be withdrawn or modified at any time that the WMC certifies to WPB that an employer has refused to comply with an employment ceiling or hiring regulation within a reasonable time after notification of failure in compliance. Employer will be given appropriate notice and opportunity for a hearing before a WPB Compliance Commissioner. Issued 12-23.

Foreign Economic Administration

EXPORTS—Gen. Licenses, Am. 270—$1 limit set on export of butadiene, petroleum blending agents except isopropyl ether, rubber, tetraethyl lead; $100 limit on carbon black (furnace and channel types), furfural, ethylene glycol, isopropyl alcohol, liquid gum inhibitors, high flash naphtha; $1 on methyl alcohol, benzene, ethyl and denatured alcohol, lubricating oil additives, toluene, etc. Paraffin wax, natural gasoline, aviation motor fuels, other motor fuels and gasoline, kerosine, equipment for production of aviation fuel or tetraethyl lead and aviation lube oil may not be exported in any amount to any destination under this general license. Issued 12-19, effective 12-9.

Office of War Mobilization

12-15-44 EXPIRATION DATE EXTENDED TO 4-15-45—Deferment of Expiration of Temporary Maximum Passenger-Car Tire Price Increases—Temporary price increases for civil-

MPR 88 Copies Available

Printed copies of MPR 88, including Ams. 1 through 23, (38 pages) are available at $1 each from

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ian passenger car tires continued in effect, since increase on civilian truck tires recently extended to 4-15-45 in an amendment to RMPR 143. Issued 12-14, filed 12-22.

Interstate Commerce Commission

EXTENSION OF EFFECTIVE PERIOD OF 10-5-43 ORDER THROUGH 12-31-45—Effective date of ICC Ex Parte Nos. MC-13, MC-3, and 3666 (transportation of explosives, inflammable liquids by truck) extended through 12-31-45. Issued 12-5, filed 12-26.

Department of the Interior, General Land Office

SUBMISSION OF FULL TERMS OF ASSIGNMENTS WITHIN 90 DAYS—Circular 1589—All assignments must be submitted in triplicate within 90 days from date of execution and must contain all of terms and conditions agreed upon. Issued 12-2, approved 12-12, filed 12-22.

Black Market Naphtha Sales Virtually Over, Says OPA

NPN News Bureau

CHICAGO—Black market operations in the sale of naphtha as a motor fuel have been brought almost completely under OPA's control since the issuance of the naphtha rationing order, effective November 20, the war agency said December 29. Bernard Friedman, regional chief of enforcement for OPA's fuel and consumer goods section, explained that while some motorists may try using a naphtha not rationed under the regulation, OPA does not feel such violations will be repeated because of the disadvantages of using such a low-grade product as a motor fuel.

John R. Allen, chief hearing commissioner for the seven-state midwestern region, added further emphasis to the statement with the report that the hearing commissioner's office has heard no cases filed by OPA for violation of naphtha rationing regulations.

U. S. Court To Rule on Sale Of Chautauqua Gas Line

NPN News Bureau

WASHINGTON — Whether certain natural gas transportation facilities in Chautauqua County, N. Y., may be abandoned and sold by Penn-York Natural Gas Corp., Philadelphia, to Republic Light, Heat & Power Co., Inc., Buffalo, will be decided by FPC on the basis of evidence at a hearing on Jan. 9 at 10 a. m. in the U. S. court house, Buffalo, the commission has announced. A joint application filed by the two companies for approval of the sale will be considered at that time.

The facilities are 3941 feet of 8-inch, 8134 feet of 6-inch, 1119 feet of 4-inch and 300 feet of 3-inch pipeline extending from the vicinity of Sheridan to Republic's storage field near Arkwright, N. Y.

California Legislators Move To Tap Idle Oil Lands

NPN News Bureau

LOS ANGELES—Proposals to increase California's petroleum output by millions of barrels per year through the use of now idle public lands and modern production techniques were approved last week by an Assembly interim committee on petroleum problems which met here.

Petroleum engineers, testifying before the committee, pointed out that petroleum producers, through advancements in engineering, now are able to drill profitably from three times as many rigs in an area that was formerly exploited by one derrick. They urged legal changes to permit drilling of multiple wells from a single drilling site. Present restrictions require that drilling rigs be 150 feet apart. The engineers asked that this restriction be relaxed to permit 50 ft. spacing.

Carlyle F. Lynton, executive officer of the State Lands Division, said that a large acreage of state-owned and quasi-public lands that are potentially oil-bearing now lie idle because of legal restrictions on leasing to oil companies for development, and urged that the Legislature pass measures enabling the leasing of such lands.

"Unless this is done," Mr. Lynton said, "California will be forced to import millions of barrels of oil from other states or foreign countries to meet its needs when ample oil producing lands in our own state lie idle for lack of development."

The committee also approved for submission to the Legislature an amendment which would empower quasi-public districts to enter into oil and gas leases.

Picks Group To Name Fields

NPN News Bureau

LOS ANGELES — Glen Bowes, president of the Pacific Section of the American Assn. of Petroleum Geologists, last week named committee members to act as advisors with the California Division of Oil and Gas, the Conservation Committee of California Oil Producers, and PAW in naming of oil fields, pools and zones.

Serving on the classification committee will be Albert I. Gregersen, chairman, and Frank S. Parker, alternate chairman, regional office of PAW; James D. Dorrance, The Texas Co.; Harvey Lee, Union Oil Co. of California, and Mason Hill, Richfield Oil Co.

Western Roads Ask Dismissal Of Antitrust Oil Rate Suit

Special to NPN

LINCOLN, NEB. — The Western Assn. of Railway Executives this week asked the U. S. District Court here to dismiss an antitrust suit brought by the Justice Department against the association and its officers, 47 western railroads, their executives, the Association of American Railroads and 28 other individuals.

The association at the same time demanded that the government file a bill of particulars in event dismissal of the motion is denied, stating, among other things, wherein various major oil companies had agreed to support the defendant railroads in applications for increases of long-haul rail rates as charged by the Justice Department's suit.

The grounds for asking dismissal of the action are that the railroads were acting in accordance with a War Production Board certificate exempting them from prosecution under the antitrust laws for doing things requisite to winning the war.

The government complaint (*see NPN, Aug. 30, p. 31*) seeks dissolution of the AAR and the WARE and charges, among other things, that as part of an alleged agreement between the railroads and major oil firms, "the oil companies, notably the Standard Oil Company (Indiana) have agreed to support and have supported the defendant railroads in applications for increases of long-haul rail rates."

With respect to this and other Federal charges, the defendant counsel ask that a "bill of particulars"—which they seek in event their plea for dismissal of antitrust charges is denied—should name persons engaged in the assertedly illegal agreements, as well as dates, places, etc.

A government charge that the defendants and other co-conspirators agreed, among other things, "to fix rates for the transportation of petroleum and petroleum products both by rail and pipeline at competitive levels," was met by a WARE demand that the plaintiffs specify the types of petroleum and petroleum products involved, the exact rates charged, and when and by whom the rates were fixed.

Michigan Proration Reviewed

Special to NPN

LANSING, Mich.—P. J. Hoffmaster, supervisor of wells for the state of Michigan, will hold a proration hearing here on Jan. 10. The Deep River pool of Arenac County will come in for special consideration, Mr. Hoffmaster said, to determine the necessity or desirability of changing the production schedule from the present per well basis to one that includes the acreage of the drilling or producing unit as a factor. Production allowables for other fields will also come up.

Sums Up Present Use Of Texas' Gas; Finds Little Waste

Special to NPN

AUSTIN, Tex.—With a Texas Railroad Commission clampdown on gas use apparently in the air, Commissioner Ernest O. Thompson has released figures showing that the percentage of natural gas waste in Texas has decreased from 37% of all gas produced in 1935 to 2% in 1944.

Thompson's statement apparently was designed to cut off what he considered unwise legislative efforts to prevent the flaring of gas that is produced with oil.

"Most of the gas that is being wasted comes out of wells producing oil," he said.

"The gas is produced coincidentally with oil production. It lifts the oil to the earth's surface in many cases. If no one buys this gas it is released into the air and burned in a flare for safety's sake. If it were not burned the gas would settle in low places and might be set off by a match or a spark.

"When the uninformed see this gas being burned near oil wells they are likely to remark how much they would like that gas to burn in a stove at home. But if you told them you would give it to them if they would come and pipe it away, they would find it too costly to come and get."

A roundup of gas production and use, he said, shows this distribution: light and fuel, including gas transported by pipeline to Denver, Indianapolis, Chicago, St. Paul, Kansas City, Detroit and points in New Mexico, Tennessee and West Virginia, 36%; extraction loss in natural gasoline plants, 4%; fuel in such plants, 10%; repressuring of fields and recycling, 28%; used in lifting crude oil by reinjecting into the reservoir, 4%; manufacture of carbon black, 16%; waste 2 per cent.

Thompson said that the figures he released came from data supplied by the state's gas producers at the request of the Commission.

Sinclair Hits New Pool

NPN News Bureau

NEW YORK—The producing affiliate of Sinclair Oil Corp. has drilled another important discovery well on 2200 acres in Wyoming, it was recently announced by offices of the corporation. This drilling followed the bringing in of two pools at Sand Draw and Crook's Gap, Wyo. (*See NPN, Dec. 27, p. 34.*)

The new well, at a depth of 5200 feet, is 124 feet in productive sand. A drill stem test indicated a flow of about 1200 b/d of sweet oil, 34.6 gravity. A pipe line connecting the Wertz Field with the Sinclair refinery at Sinclair, Wyo., traverses the new pool, which lies between the Wertz Field and Mahoney Dome.

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Pyrene Foam and PlayPipe are as effective on outdoor as on indoor fires; and on solid embers as on volatile liquids, because after a fire in gasoline, oil or flammable liquids has been smothered in seconds with Pyrene Foam, by merely lifting the pick-up tube out of the container a water stream instantly replaces the foam, thus smoldering embers of adjacent fires are effectively handled.

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Kansas City Oil Men Raise Fund for Hospital At Christmas Party

Photo above shows Kansas City Oil Men's Club and guests at annual Christmas party in the President Hotel, Kansas City, Dec. 21

Special to NPN

KANSAS CITY, Mo.—Two hundred and twenty-five oil men, members of the Oil Men's Club of Kansas City, following their custom of making a substantial donation to charity at Christmas time, donated $830.50 for a special project for Mercy Hospital here at the annual Christmas party at the President Hotel on Dec. 21.

In the past the club has provided clothing, fuel, and toys for many destitute families. This year because most families are self supporting, the club's Welfare Committee, after an investigation of deserving projects, learned that the Mercy Hospital, a non-sectarian, charitable institution was in need of mattresses for the beds of sick and crippled children.

Through mail solicitation, $361 was obtained, and at the Christmas party a collection added $469.50 to the fund. This means that the hospital, supported by voluntary contributions, will be able to supply new mattresses, both full and crib size, to unfortunate sick and crippled children.

C. R. Huston was Chairman of the Program and Entertainment Committee. Guests included representatives of equipment and supply companies, prominent professional men, co-operative societies, and others. The members of the club exchanged gifts.

Pastor Outlines Need

E. C. Hauber, chairman, introduced the Rev. David Henry Owen who gave a brief explanation of the need for the additional mattresses at the hospital. At the speaker's table with the Rev. Owen were Edw. C. Hauber, Chairman; "Candy" Huston, Chairman of program and entertainment; Justin D. Bowersock, Kansas City Star; Glen Speakman, Butler Mfg. Co.; Jake Wyatt, Consolidated Fuel Oil Co.; Billy Knapp, the Wm. A. Knapp Co.; Roy S. Reed, Kanotex Refining Co.; Walt. Fredericksen, secretary; W. H. Gadberry, Columbian Steel Tank Co.; L. P. Cookingham, city manager; the Rev. J. Freidel, Rockhurst College; Leo Barry, Phillips Petroleum Co.; N. M. Potts, Continental Can Co.; and Arnold Sherwood, Bertram Naphtha Co.

THINGS YOU SHOULD KNOW about PUMPS for Handling PETROLEUM PRODUCTS

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1945 Rubber Problem Mainly Manpower, Says Goodrich Head

NPN News Bureau

CLEVELAND—In a year-end review of the rubber situation, John L. Collyer, president, B. F. Goodrich Co., said that the main problem of the rubber industry was no longer one of raw material, but how, with the manpower available, to build the material into sufficient war goods to meet the desperate needs. He predicted that this would continue to be the No. 1 problem in 1945.

Highly significant, he said, was the fact that synthetic rubber production climbed to a rate of 800,000 tons a year. This is more than this nation ever consumed, even in the all-time record year of 1941, when 781,000 tons were used.

The rapidity and completeness of the industry's changeover is revealed by a review of consumption totals from that last prewar year to the year just closed:

In 1941, only 6,000 tons—eight-tenths of 1 per cent of that all-time high consumption total—was synthetic rubber.

Deep Cut in 1942

In 1942, our first year at war, rubber consumption was cut to 394,000 tons, of which 17,000 tons, or 4½%, were synthetic.

In 1943, with large-scale synthetic rubber production getting under way, synthetic accounted for 171,000 or 35%, of the total of 489,000 tons.

Total consumption in 1944 was about 710,000 tons, of which 565,000 tons were synthetic. During the last quarter, the percentage of synthetic rubber being used had risen to 85%.

Commenting on this record, Mr. Collyer said: "This amazing record of production and ability to use a new raw material has been a lifesaver, as we are nearer today to the bottom of the natural rubber barrel than ever before, and military requirements continue to mount as our active war front widens and supply lines lengthen."

Average Price 30 Cents

Analyzing the implications of the synthetic rubber situation as regards postwar industry, Mr. Collyer said that it was still impossible to forecast the "balance of power" between synthetic and natural rubber when Far Eastern rubber again becomes available in volume. But experience in 1944, he said, has confirmed the belief that after the war natural and synthetic rubbers will be in competition over a wide field.

On this subject, he said:

"The last prewar market price of natural rubber from the Far East was 22 cents a pound, though we know that the eastern plantations could lay down rubber in New York at 10 to 12 cents a pound, and still make a reasonable profit.

"While the average cost of all main-

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is performance!

The octane number rating as the sole factor in valuing gasoline has been challenged repeatedly by reputable oil chemists and technical experts. No one denies that anti-knock performance is desirable in a motor fuel, *but* other factors are equally, if not more, important. These factors should be evaluated and considered along with octane in determining what makes a Premium Fuel.

More mileage—increased power—less carbon—gum inhibiting—cooler running—better lubrication—longer life—fewer repairs are all desirable factors in motor performance. Any motor fuel which has been tested under actual road conditions over a period of years and has proved that it has all of these qualities is truly a Premium Quality Gasoline.

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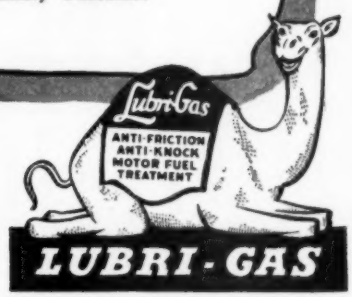

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type synthetic rubber made to date is in excess of 30 cents a pound, it is significant that in certain plants it has been made at a cost of 14 cents a pound, exclusive of amortization and depreciation of plant.

"If we were to add a cent a pound for amortization, another for storage and distribution charges, and allow for a profit without which venture capital could not be attracted to the synthetic rubber industry, the price would be in the neighborhood of 20 cents a pound.

"It should be remembered, however, that a simple cents-per-pound comparison can be misleading, because differences in processing costs between the two materials, and differences in finished-product performance must be taken into account. So it cannot be said that synthetic rubber has already attained an economic advantage over natural rubber under normal conditions.

"The key fact is that America's synthetic rubber performance has provided an effective ceiling over future raw rubber costs, which is important to the goal of more and better products, wider markets, more jobs."

Rubber Group Offers Prizes For Synthetic Scrap Uses

NPN News Bureau

CHICAGO—The best solution to the problem of how to utilize cured synthetic scrap rubber will win a prize of $500 in a contest being sponsored by the Chicago Rubber Group. Selection of subject matter for the papers is left to the discretion of the authors, but information must be completely new in the respect that it has not been presented before any technical meeting or published in any trade magazine. Papers may deal with any phase of the problem.

Rules listed for the contest permit the entry of anyone in the United States or Canada with the exception of officers and directors of Rubber Group. The contest will close at midnight on August 1, 1945. Papers should be submitted in triplicate to Mr. A. R. Floreen, vice president, City National Bank and Trust Co., 208 S. LaSalle street, Chicago 90, who will forward one copy to each of the three judges. Papers submitted as entries in the contest should contain no information that may identify the author to the judges. Judges for the contest are being selected by the Rubber Manufacturers Association, the Rubber Reclaimers Association and the Rubber Division of the American Chemical Society.

There will be a second prize of $300 and a third prize of $200 as well as the $500 first prize. Awards will be made at the fall meeting of the American Chemical Society in Chicago next year.

The Chicago Rubber Group is sponsored by the Division of Rubber Chemistry of the American Chemical Society. B. W. Hubbard is chairman.

Sohio Family To Mark 75 Years With Parties in 20 Cities

NPN News Bureau

CLEVELAND — With the approach of the 75th anniversary of the founding of the Standard Oil Co. (Ohio) on Jan. 10, arrangements are being completed for 20 parties which will include a musical broadcast, the "Cavalcade of Ohio", with Deems Taylor as narrator. W. T. Holliday, president, will send a message to the family of the original Standard of Ohio company now scattered over eight states.

The parties will be in the following places:

Evansville, Ind., W. A. Osborne in charge, expected attendance, 200; Jackson, Miss., Dallas Rummager in charge, expected attendance, 175; Oklahoma City, Okla., J. Marshall Nye in charge, expected attendance, 150; Russell, Kans., J. A. Riise in charge, expected attendance, 200; Shreveport, La., C. J. Haas in charge, expected attendance, 100; Akron, O., R. H. Collacott in charge, expected attendance, 475; Canton, O., S. J. Harrison in charge, expected attendance, 400; Cincinnati, A. B. Caldwell in charge, expected attendance, 550; Columbus, O., A. W. Lawyer in charge, expected attendance, 600; Dayton, O., C. H. Margraf in charge, expected attendance, 500; Lima, O., C. A. Doyle and Charles Cleveland in charge, expected attendance, 1000; Mansfield, O., C. J. Baer in charge, expected attendance, 150; Marion, O., J. P. Sharkey in charge, expected attendance, 175; Portsmouth, O., G. H. Bachtrup in charge, expected attendance, 225; Toledo, O., R. G. Tracy in charge, expected attendance, 800; Youngstown, O., F. H. Kennedy in charge, expected attendance, 400; Zanesville, O., F. H. Kennedy in charge, expected attendance, 400; St. Louis, Mo., J. F. Wilson and E. F. Morrell in charge, expected attendance, 750; St. Louis, Mich., M. W. Walter in charge, expected attendance, 100.

A party will also be held in Indianapolis, with 100 expected, but plans have not yet been completed.

Jersey Standard Officials Pay Final Honors to C. H. Lieb

NPN News Bureau

NEW YORK—A delegation of eight officers of the Standard Oil Co. (N. J.) left here to attend funeral services for C. H. Lieb in Tulsa, Okla. on Jan. 4.

Mr. Lieb, president of Creole Petroleum Corp., died in Palm Beach, Fla. Dec. 30, after a brief illness. He was 50.

Mr. Lieb

Personal friends of Mr. Lieb will act as pallbearers. They include O. C. Schorp, president of Carter Oil Co., and Herbert Miller, also of Carter Oil Co. Representatives of Jersey Standard who will attend the services include F. W. Abrams, F. H. Bedford, E. F. Johnson, F. T. Fly, John L. Kalb, L. F. McCollum, W. S. Sollenberger and J. E. Crane.

Mr. Lieb had been connected with Jersey Standard and its affiliates since 1917, when he joined Carter Oil as a draftsman and engineer. Two years later he went to Vera Cruz, Mex., as construction supervisor for Compania Transcontinental de Petroleo.

Four years later he was recalled to the United States to become president of Carter Oil Co., at Tulsa. By 1938 he was in New York co-ordinating producing activities for the central Standard Oil Co. (N. J.) organization. In 1941 he was elected president of the Creole company.

Mr. Lieb was chairman of the producing sub-committee of the Caribbean Area Petroleum Committee of PAW.

He is survived by his widow, a son and a foster son, and a brother.

Phillips To Dedicate New Lab

Special to NPN

BARTLESVILLE—An "open house" to dedicate Phillips Petroleum Co.'s new research laboratories and pilot plant facilities at Phillips, Tex. (near Amarillo and Borger) will be held Jan. 5, according to a company announcement. Special guides will direct visitors to such key points as the pure hydrocarbon manufacturing plant, the small-scale ethyl blending plant, warehouse, main laboratory building, and the three nearby pilot plants. G. H. Short, research department, will direct operations at the new facilities.

Byrnes Demands Tighter Manpower Controls

NPN News Bureau

WASHINGTON—The need for all-out war production "until one of our enemies is defeated" brought a demand from War Mobilization Director James F. Byrnes this week for enactment of legislation that will tighten government controls on manpower.

Included among recommendations submitted to Congress by Justice Byrnes in his first quarterly report as chief of the Office of War Mobilization and Reconversion was one that consideration be given to measures to force men physically disqualified for front-line military service into essential war activities.

Warning that our adversaries are still dangerous and that there is still much to be done, Justice Byrnes told Congress that "we cannot be complacent yet."

"We must man our war plants to the fullest extent necessary to meet the requirements of our military leaders," he said. "We must do this in the face of a further withdrawal from our available manpower supply to provide replacements for the Army and to build the Navy up to the strength which it requires to man its ships."

Not only did he propose handling 4-F's what amounts almost to a choice of "work-or-fight," but he suggested also the desirability of legislation to strengthen the authority of both the War Manpower Commission and the War Labor Board. Of the latter, he said that ways must be found for WLB to enforce its decisions in the courts without resort to seizure—"so that we may treat the Petrillos and the Averys alike."

If Congress should authorize the draft of 4-F's for limited military service or work in war plants, as recommended by Justice Byrnes, it will probably have these effects in the oil industry:

1. Reduce quitting by 4-F's in the essential branches—production, refining and transportation.

2. Force the shift to war plants of some 4-F's in distribution and marketing, where these branches have not been declared "locally-needed."

(PAW could be expected, however, to fight for recognition by Selective Service, or War Manpower Commission, of the essential nature of distribution and marketing declared locally-needed. Such recognition would give these activities protection against losing 4-F's, either to the military or to other industries, while at the same time acting as an inducement to these workers to stay on the job.)

While emphasizing that the war effort must continue "as our primary national objective," Justice Byrnes' report dealt extensively with the problem of planning an orderly, gradual transition from all-out war production to a peacetime economy.

To this end, among other things, he recommended the removal by Congress of obstacles in the way of business expansion and reconversion, including various tax impediments.

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WAR-OIL COMMUNICATION SERVICES

Market Reports

ATLANTIC COAST — No price changes were reported throughout the week. Current reports indicate gasoline supplies at seaboard points are becoming increasingly tight. A shortage of transport trucks plus bad weather conditions were seriously handicapping distributors in the Philadelphia area.

Supplier in Baltimore commenting on PAW's increase in premium gasoline (Amendment to PDO 21), effective Jan. 1 for civilian consumption, said increase would aid distributors but little since premium sales in his area have always been very high.

* * *

CALIFORNIA—Markets steady and prices unchanged. Greatest demand was for heating oil. It is estimated that this area is short 35,000 b/d, with the situation expected to become worse. Demand for gasoline is not as strong as in the past. Almost all service stations place no limit on the amount of gasoline they will sell.

* * *

GULF COAST—New quotations were posted for unleaded gasoline 70 oct., when refiner quoting 5.75 cts posted ceiling of 5.625 cts. The published price of 5.5 cts was eliminated when the only refiner posting withdrew his quotation for 67-68 octane gasoline since he is no longer making it.

Refiner in New Orleans reported some improvement in transportation situation. Although tank cars are tight, some improvement is noted in barge deliveries, he said.

* * *

MIDCONTINENT—Oklahoma refiner re-entered 4.375c posting on 41-43 w.w. kerosine since he is making the product again. Flat price of 4.375c unchanged.

Open spot sales of 15 cars No. 6 fuel oil at 97c to Dist. 2 in seller's cars were reported by Oklahoma refiner. Heavy fuel oil reported tightening considerably, and definite increase is being felt in demand for heating oils. Many refiners are having to turn down East Coast inquiries and are prorating to regular customers. Tank car shortage continues to hold up shipments. Gasoline demand said to be off seasonally except in Texas where one refiner remarked that December demand based on sales of all grades has exceeded any month since last August.

One car Grade 26-70 natural gasoline reported sold at 4.75c f.o.b. Group 3. No open spot sales were reported f.o.b. Breckenridge; sellers quoted 4.375c during the week.

* * *

MIDWEST — Keeping heating oils moving to fill extremely strong demand of past week in face of transportation breakdowns. Refiners and marketers complain of tank car shortages, trucks stalled on bad roads and laid up because of lack of repair parts and tires. Many drivers refuse to take trucks out under present conditions. Heating oil storages are normally adequate to fill demand but "not available in the right place at the right time".

Michigan refiners, however, complain of actual shortage of products as well as transportation difficulties.

Many Midwestern refiners report prorating heating oils. Some marketers, formerly dependent upon group 3 market now forced to turn to local markets for range oil, kerosine and No. 2 when they can't get tank cars to move material from the Southwest. Delivery delays range from several days to two weeks.

Demand for all other products fairly strong. Residual oils tightening somewhat.

* * *

PENNSYLVANIA—With only 70% of pipeline crude going to Pennsylvania refiners, products yields have been considerably slowed down in recent weeks. Bad weather plus transportation difficulties have further complicated deliveries, hence a tight situation in refined products was generally reported.

Commenting on the wax shortage, one refiner said the product is tight since refiners are unable to get permits for export shipping.

N.P.N. Gasoline Index

	Dealer T.W.	Tank Car
	Cents Per Gal.	
Jan. 2	10.38	6.72
Month ago	10.43	6.72
Year ago	10.45	6.81

Dealer index is an average of "undivided" dealer prices, ex-tax, in 50 cities.

Tank car index is weighted average of following wholesale markets for regular-grade gasoline, FOB refineries or terminals: Okla., Mid-Western, W. Penna., Calif., N. Y. Harbor Philadelphia, Jacksonville, Boston and Gulf Coast.

CRUDE PRICES

Since changes in crude oil prices are so few, the two pages of crude oil price tables hereafter will be printed only when there are sufficient changes in prices to warrant.

In the meantime a record is being kept in the Cleveland office of NPN and OILGRAM from which the publishers will be glad to make proofs, or letters or affidavits as to what the prices are, and without charge to regular subscribers. Changes in crude oil prices will be specially noted in this market section when made.

Crude Price Changes

No price changes reported for week ending Dec. 27.

For latest table of crude prices published, see NPN, Dec. 27, pages 52, 53 and 46.

Summary of Daily Gasoline Prices (December 25 to January 1)

	Friday Dec. 29	Thursday Dec. 28	Wednesday Dec. 27	Tuesday Dec. 26
U. S. Motor (ASTM octane)				
76 octane Ethyl:				
Oklahoma	6.75	6.75	6.75	6.75
Mid-Western (Group 3 basis)	6.75	6.75	6.75	6.75
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	7	7	7	7
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	7 (2)	7 (2)	7 (2)	7 (2)
70-74 octane:				
Oklahoma	5.875	5.875	5.875	5.875
Mid-Western (Group 3 basis)	5.875	5.875	5.875	5.875
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.875	5.875	5.875	5.875
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.875	5.875	5.875	5.875
63-66 octane:				
Oklahoma	5.625 (1)	5.625 (1)	5.625 (1)	5.625 (1)
Mid-Western (Group 3 basis)	5.625 (2)	5.625 (2)	5.625 (2)	5.625 (2)
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.625 (1)	5.625 (1)	5.625 (1)	5.625 (1)
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.625 (1)	5.75 (1)	5.75 (1)	5.75 (1)
60 octane & below:				
Oklahoma	5.25	5.25	5.25	5.25
Mid-Western (Group 3 basis)	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.25	5.25	5.25	5.25
Motor Gasoline, 70-74 oct.				
New York harbor	9.075	9.075	9.075	9.075
New York harbor, barges	8.975	8.975	8.975	8.975
Philadelphia district	9.075	9.075	9.075	9.075
Baltimore district	8.825	8.825	8.825	8.825
Motor Gasoline:				
Western Penna. Bradford-Warren:				
"Q" Gasoline, Min. 70 Oct. (ASTM)	7.625- 8.225	7.625- 8.225	7.625- 8.225	7.625-8.225
Western Penna. Other Districts:				
"Q" Gasoline, Min. 70 Oct. (ASTM)	7.725	7.725	7.725	7.725

Note: To conform with Article IV of MPR 88 as amended August 15 we are substituting 70-74 oct. ASTM for the old 72-74 oct. ASTM. We continue to include in this group, Housebrand quotations.

REFINERY OPERATIONS

(American Petroleum Institute figures in thousands of barrels of 42 gal. each. Figures include reported totals plus estimate of unreported amounts and are therefore on a Bureau of Mines basis.)

Districts	Daily Potential Refining Capacity Week Ended		Daily Average Crude Runs to Stills Week Ended		Gasoline Production at Refineries inc. Natural Blended Week Ended		Kerosine Production Week Ended		Gas Oil & Dist. Fuel Oil Production Week Ended		Residual Fuel Oil Production Week Ended	
	Dec. 23	Dec. 16	Dec. 23	Dec. 16	Dec. 23	Dec. 16	Dec. 23	Dec. 16	Dec. 23	Dec. 16	Dec. 23	Dec. 16
East Coast	729	729	687	695	1,751	1,684	153	193	1,062	836	1,430	1,272
Appalachian (Dist. No. 1)	130	130	98	100	278	295	65	63	72	74	89	94
Appalachian (Dist. No. 2)	47	47	58	48	164	167	12	5	40	60	79	72
Ind., Ill., Ky.	824	824	802	762	3,000	2,783	259	248	624	693	1,242	1,137
Okla., Kans., Mo.	418	418	371	370	1,440	1,335	133	126	359	362	473	489
Inland Texas	278	278	232	222	902	862	87	72	114	115	461	482
Texas Gulf Coast	1,165	1,165	1,147	1,111	3,373	3,451	405	338	1,354	1,327	1,990	1,904
Louisiana Gulf Coast	242	242	262	258	793	880	263	240	283	254	318	314
No. La., & Arkansas	104	104	69	67	193	195	39	35	48	42	95	95
Rocky Mt. (Dist. No. 3)	13	13	10	12	35	38	4	4	7	7	30	31
Rocky Mt. (Dist. No. 4)	141	141	110	107	394	347	12	14	84	72	200	217
California	817	817	836	785	2,312	2,108	45	82	558	511	2,391	2,620
Total U. S.—B. of M. Basis	4,908	4,908	4,682	4,537	14,635	14,145	1,477	1,420	4,605	4,353	8,798	8,727
U. S.—B. of M. Basis Dec. 25, 1943			4,204		12,576		1,500		4,411		8,697	

Districts	Stocks of Finished & Unfinished Gasoline Week Ended		Total Stocks Kerosine Week Ended		Total Stocks Gas Oil & Distillates Week Ended		Total Stocks Residual Fuel Oil Week Ended	
	Dec. 23	Dec. 16	Dec. 23	Dec. 16	Dec. 23	Dec. 16	Dec. 23	Dec. 16
East Coast	12,543	12,533	4,955	5,411	10,899	11,556	7,577	8,196
Appalachian (Dist. 1)	2,580	2,577	483	416	517	512	359	361
Appalachian (Dist. 2)	1,705	1,687	82	63	211	220	204	185
Ind., Ill., Ky.	17,706	17,110	2,469	2,511	6,377	6,682	3,264	3,358
Okla., Kans., Mo.	7,975	8,059	715	766	2,299	2,419	1,526	1,602
Inland Texas	2,779	2,808	184	206	393	388	624	643
Texas Gulf Coast	14,840	14,519	1,338	1,397	6,718	6,814	9,120	8,995
Louisiana Gulf Coast	4,358	4,507	883	868	1,777	1,933	1,172	1,115
N. La. & Arkansas	2,401	2,436	266	146	563	642	227	245
Rocky Mt. (Dist. 3)	69	68	10	10	19	19	31	31
Rocky Mt. (Dist. 4)	1,614	1,611	92	95	353	338	503	508
California	14,795	14,829	496	511	10,720	10,890	33,902	34,041
Total U. S.—B. of M. Basis	88,365*	82,747	11,973	12,400	40,846	42,413	58,509	59,280
U. S.—B. of M. Basis Dec. 25, 1943	73,019		9,933		43,033		57,036	

*Composed of 12,918,000 bbl. of unfinished, 42,135,000 bbl. civilian grade automotive, and 28,312,000 bbl. aviation, military, solvents, and naphthas and gasoline blending stocks currently indeterminate as to ultimate use.

Daily Av. Pennsylvania Crude Runs

(Compiled by National Petroleum Assn. from reports of all companies refining Pennsylvania crude. Figures in bbls.)

Week Ended Dec. 23, 1944	Week Ended Dec. 16, 1944	Week Ended Dec. 25, 1943
62,477	60,900	62,089

U. S. Crude Oil Production

(American Petroleum Institute figures)

	WEEK ENDED Dec. 23 Barrels (Daily Average)	Dec. 16 Barrels (Daily Average)
Oklahoma	359,400	358,200
Kansas	279,250	267,300
Nebraska	1,000	1,050
Texas	2,111,550	2,111,550
Louisiana	361,050	360,850
Arkansas	80,550	80,900
Mississippi	52,050	52,100
Alabama	200	250
Florida	50	50
Illinois	204,750	195,600
Indiana	12,900	11,550
Eastern (Ill., Ind. & Ky. excluded)	62,950	59,600
Kentucky	33,250	29,350
Michigan	47,200	52,650
Wyoming	98,350	95,950
Montana	21,300	21,300
Colorado	9,600	8,850
New Mexico	103,200	103,200
California	890,500	885,300
Total, U. S.	4,729,100	4,695,600

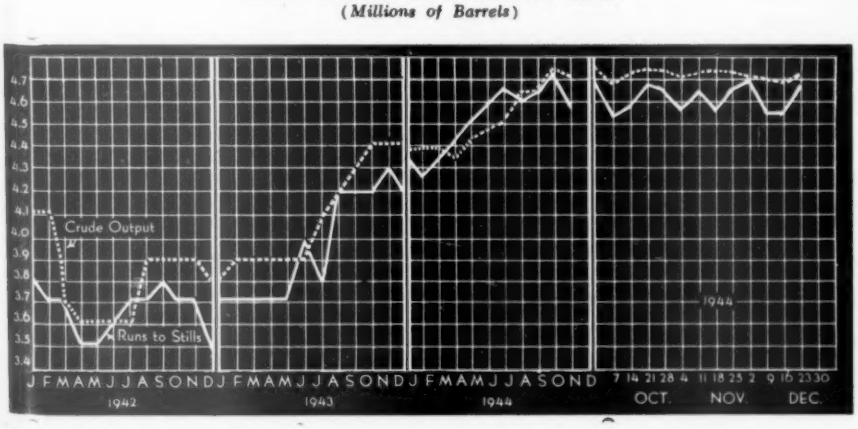
Crude Oil Stocks

(Bureau of Mines Figures in thousands of bbls.)

Grade or Origin	Dec. 16	Dec. 23	Change from Dec. 16
Penna. Grade	2,189	2,150	— 39
Other Appalachian	1,491	1,471	— 20
Lima-Michigan	987	957	— 30
Illinois-Indiana	13,906	13,956	+ 50
Arkansas	2,874	2,894	+ 20
Kansas	8,126	8,310	+184
Louisiana:	13,521	13,682	+161
Northern	3,411	3,397	— 14
Gulf Coast	10,110	10,285	+175
Mississippi	1,088	979	—109
New Mexico	6,503	6,707	+204
Oklahoma	29,722	30,177	+455
Texas:	111,122	111,310	+188
East Texas	19,217	19,504	+287
West Texas	31,807	31,424	—383
Gulf Texas	30,991	31,172	+181
Other Texas	29,107	29,210	+103
Panhandle	6,226	6,361	+135
North	7,133	7,170	+ 37
South	6,867	6,884	+ 17
Other	8,881	8,795	— 86
Rocky Mountain	7,297	7,304	+ 7
California	20,690	20,254	—436
Foreign	2,559	2,424	—135
Total gasoline-bearing in U. S.	222,075	222,575	+500
Heavy in California	6,528	6,456	— 72

Crude Production & Runs to Stills

(Millions of Barrels)


Crude Output
Runs to Stills
1942
1943
1944
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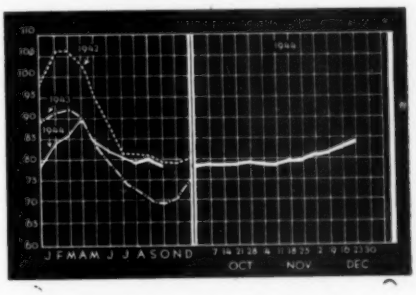
OCT.
NOV.
DEC.

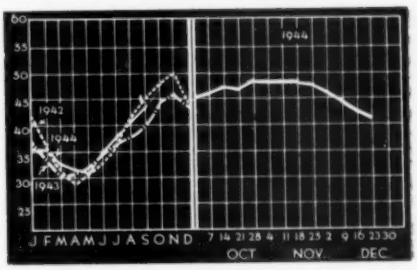
Gasoline Stocks

(Millions of Barrels)



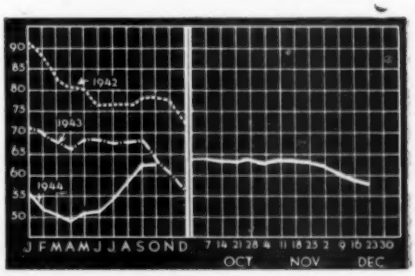
Gas Oil & Distillate Stocks

(Millions of Barrels)



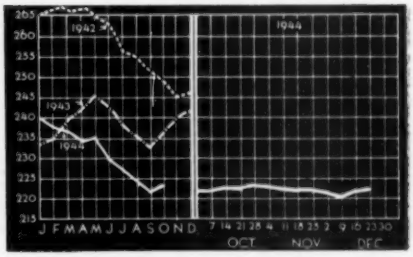
Residual Fuel Oil Stocks

(Millions of Barrels)



Crude Oil Stocks

(Millions of Barrels)



OIL PRICE SECTION ★ At Refineries and Terminals and by Tank Wagon

Prices herewith are reproduced from Platt's *OILGRAM* Daily Oil Price Service, associated with National Petroleum News, whose representatives in all *NPN-OILGRAM* offices devote their time exclusively to reporting oil industry prices everywhere.

Prices shown are actual sales prices, or quotations meaning sellers' general offers or posted prices; for current sales and shipment; for the business day or period stated; except Tank Wagon prices, prices are for bulk lots such as tank car and motor transport; barge or tanker cargo lot prices are identified; FOB refineries or terminals; in cents per gal. except where shown in bbls. of 42 gals.; ex all fees and taxes; for crude oil and its products lawfully produced and transported; reported as received by *OILGRAM* and National Petroleum News but not guaranteed; for subscribers' private use only and not for resale or distribution or publication. For further details of price conditions apply to any *NPN-OILGRAM* office or see back of any *OILGRAM* Price Service invoice.

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Refinery Prices

Gasoline —U. S. Motor (A S T M) except where otherwise specified.

Prices in Effect	Jan. 1	Dec. 25
OKLAHOMA		
76 oct. Ethyl...	6.75	6.75
70-74 oct.....	5.875	5.875
63-66 oct.....	5.625 (1)	5.625 (1)
60 oct. & below.	5.25	5.25
MID-WESTERN (Group 3 basis)		
76 oct. Ethyl...	6.75	6.75
70-74 oct.....	5.875	5.875
63-66 oct.....	5.625 (2)	5.625 (2)
60 oct. & below.	5.2 - 5.25	5.2 - 5.25
N. TEX. (For shpt. to Tex. & N. M. dest'ns.)		
76 oct. Ethyl...	7	7
70-74 oct.....	5.875	5.875
63-66 oct.....	5.625 (1)	5.625 (1)
60 oct. & below.	5.2 - 5.25	5.2 - 5.25
W. TEX. (For shpt. to Tex. & N M. dest'ns.)		
76 oct. Ethyl...	7 (2)	7 (2)
70-74 oct.....	5.875	5.875
63-66 oct.....	5.75 (1)	5.75 (1)
60 oct. & below.	5.25	5.25
CENT. W. TEX. (Prices to truck transports)		
76 oct.....	7 (2)	7 (2)
70-74 oct.....	5.875 (2)	5.875 (2)
67-69 oct.....	....	....
62 oct. & below.	5.25 (2)	5.25 (2)
KANSAS (For Kansas destinations only)		
76 oct. Ethyl...	7.2 - 7.3	7.2 - 7.3
70-74 oct.....	6.2	6.2
63-66 oct.....	5.9 (2)	5.9 (2)
60 oct. & below.	5.5	5.5
ARK. (For shipment to Ark. & La.)		
76 oct. Ethyl...	7 (1)	7 (1)
70-74 oct.....	5.875 (1)	5.875 (1)
62 oct. "	....	....
60 oct. & below, unleaded.....	5.25 (1)	5.25 (1)
WESTERN PENNA. (Motor gasoline)		
Bradford-Warren:		
"Q" Gasoline Min. 70 Oct. (ASTM)	7.625-8.225(a)	7.625-8.225(a)
Other districts		
"Q" Gasoline, Min. 70 Oct. (ASTM)	7.725	7.725

(a) Highs and lows for Schedule D area, in MPR 88 and outside Schedule D area, respectively.

Prices in Effect	Jan.	Dec. 25
CENTRAL MICHIGAN (FOB Central Mich. refinery group basis for shpt. within Mich.; shpts. may originate at plants outside Central group.)		
U.S. Motor: (Oct. ASTM):		
70-74 oct.....	7.875- 8.375	7.875- 8.375
67-69 oct.....	....	....
Str. run gasoline, excluding Detroit shpt.....	6	6
OHIO (S. O. Ohio quotations for statewide delivery and subject to exceptions for local price disturbances).		
70-74 oct.....	8.25	8.25
CALIFORNIA U.S. Motor:		
76 oct. (Ethyl)....	7.5 - 8.75	7.5 - 8.75
70-74 oct.....	6.5 - 7.75	6.5 - 7.75
65 oct. & below (3rd grade).....	5.75 - 6.25	5.75 - 6.25

Kerosine, & Gas Fuel Oils

OKLAHOMA		
41-43 grav. w.w...	4.375	4.375
42-44 grav. w.w...	4.5	4.5
Range oil.....	4	4
No. 1 p.w.....	3.875	3.875
No. 1 straw.....	....	....
No. 2 straw.....	3.625	3.625
No. 3 fuel.....	3.5 (2)	3.5 (2)
No. 6 fuel.....	$0.90-$0.97	$0.90-$0.97
U. G. I. Gas Oil..	....	....
14-16 fuel.....	$0.97 (2)	$0.97 (2)
MID-WESTERN (Group 3 basis)		
41-43 grav. w.w...	4.375	4.375
42-44 grav. w.w...	4.5	4.5
Range Oil.....	4 -4.1 (2)	4 -4.1 (2)
No. 1 p.w.....	3.875	3.875
No. 2 straw.....	3.625	3.625
No. 3.....	....	....
No. 5.....	....	....
No. 6.....	$0.97 (1)	$0.97 (1)
N. TEX. (For shpt. to Tex. & N. M. dest'ns.)		
41-43 grav. w.w...	4.375	4.375
42-44 grav. w.w...	4.5 (1)	4.5 (1)
No. 1 p.w.....	3.875 (1)	3.875 (1)
No. 6 fuel.....	$0.90-$0.97(2)	$0.90-$0.97(2)
AMARILLO, TEX. (For shpt. to W. Okla. & Tex. differential territory.)		
42-44 grav. w.w...	4.5 (1)	4.5 (1)
KANSAS (For Kansas destinations only).		
41-43 grav. w.w...	No Price	No Price
42-44 grav. w.w...	4.7	4.7
No. 1 p.w.....	4.1	4.1
No. 6 fuel.....	$0.95-$1.02	$0.95-$1.02
ARK. (For shipment to Ark. and La.)		
41-43 grav. w.w...	....	....
42-44 w.w. kero...	4.5 (1)	4.5 (1)
No. 1.....	....	....
No. 2.....	3.625 (1)	3.625 (1)
No. 3 fuel.....	3.5 (1)	3.5 (1)
Tractor fuel, for shpt. to Ark. points only.....	5.125 (1)	5.125 (1)
Diesel fuel 52 & below.....	4 (1)	4 (1)
Diesel fuel 58 & above.....	4.25 (1)	4.25 (1)
WESTERN PENNA.		
Bradford-Warren:		
45 grav. w.w.....	6.5 - 7.55	6.5 - 7.55
46 grav. w.w.....	.....	.....
No. 1 fuel.....	6.55-7.55(2&b)	6.55-7.55(2&b)
No. 2 " ...	6.125-7.125(2&b)	6.125-7.125(2&b)
No. 3 "	6.25-7.25(1&b)	6.25-7.25(1&b)
36-40 gravity.....	6.625-6.75(2)	6.625-6.75(2)
(b) Highs and lows for Schedule D area, in MPR 88 and outside Schedule D area, respectively.		
Other districts:		
45 grav. w.w.....	7 - 7.425	7 - 7.425
46 grav. w.w.....	7.25 - 7.375	7.25 - 7.375
47 grav. w.w.....	7.375- 7.50	7.375- 7.50
No. 1 fuel.....	6.875- 7.125	6.875- 7.125
No. 2 "	6.75 - 6.875	6.75 - 6.875
No. 3 "	6.75	6.75
36-40 grav. Pittsburgh dist. prices excluded.....	6.625-6.875	6.625- 6.875
CENTRAL MICHIGAN (FOB Central Mich. refinery group basis for shpt. within Mich.; shpts. may originate at plants outside Central group.)		
47-49 gravity w.w.	5.8 - 6	5.8 - 6
P.W. Distillate...	5.5	5.5
No. 3 gas oil, Straw	5	5
U.G.I. gas oil.....	4.5 (2)	4.5 (2)
Fuel Oils (*Vis. at* 100).		
300-500 Vis....	4.14 (1)	4.14 (1)
100-300 Vis....	4.5	4.5
OHIO (S. O. quotations for statewide delivery)		
Kerosine.....	7	7

Prices in Effect	Jan. 1	Dec. 25
CALIFORNIA		
40-43 grav. w.w...	5 - 7	5 - 7
San Joaquin Valley:		
Heavy fuel.....	$1.10 (2)	$1.10 (2)
Light fuel.....	$1.20 (2)	$1.20 (2)
Diesel fuel.....	4 (2)	4 (2)
Stove dist.....	5 (2)	5 (2)
Los Angeles:		
Heavy fuel.....	$1.10 (2)	$1.10 (2)
Light fuel.....	$1.20 (2)	$1.20 (2)
Diesel fuel.....	4 (2)	4 (2)
Stove dist.....	5 (1)	5 (1)
San Francisco:		
Heavy fuel.....	$1.15 (1)	$1.15 (1)
Light fuel.....	$1.25 (1)	$1.25 (1)
Diesel fuel.....	4.5 (1)	4.5 (1)
Stove dist.....	5.5 (1)	5.5 (1)

NOTE: All above heavy fuels meet Pacific specification 400; light fuel, spec. 300; Diesel fuels spec. 200; and stove distillate, spec. 100.

Lubricating Oils

Prices in Effect	Jan. 1	Dec. 25
WESTERN PENNA.		
Prices are for sales made, or offers reliably reported, to jobbers & compounders only.		
Viscous Neutrals—*No. 3 col. Vis. at* 70°*F.*		
200 Vis. (180 at 100°) 420-425 fl.		
0 p.t.....	38 (1)	38 (1)
10 p.t.....	37 (1)	37 (1)
15 p.t.....	36 (1)	36 (1)
25 p.t.....	28-33	28-33
150 Vis. (143 at 100°) 400-405 fl.		
0 p.t.....	36 (1)	36 (1)
10 p.t.....	35 (1)	35 (1)
15 p.t.....	34 (1)	34 (1)
25 p.t.....	26-31	26-31
NOTE: Limited quantity neutrals available to regular trade.		
Cylinder Stocks:		
Brt. stk., 145-155 *vis. at* 210°, 540-550 fl., *No. 3 col.*		
10 p.t.....	30.5 (1)	30.5 (1)
15 p.t.....	29.5 (1)	29.5 (1)
25 p.t.....	25	25
600 S.R. filterable	15	15
650 S.R.....	15.5	15.5
600 fl.....	16	16
630 fl.....	17	17
MID-CONTINENT (F. o. b. Tulsa)		
Neutral Oils (*Vis. at* 100° *F. 0 to* 10 *P.P.*)		
Pale Oils:		
Vis. Color		
60-85—No. 2....	7.5	7.5
86-110—No. 2...	7.5 - 8.5	7.5- 8.5
150—No. 3.....	11 -11.5	11 -11.5
180—No. 3.....	11.5 -15	11.5-15
200—No. 3.....	12 -15	12 -15
250—No. 3.....	14 -16.5	14 -16.5
280—No. 3.....	15 -17	15 -17
300—No. 3.....	16 -18	16 -18
Red Oils:		
180—No. 5.....	11.5 (1)	11.5 (1)
200—No. 5.....	12 (1)	12 (1)
280—No. 5.....	No Price	No Price
300—No. 5.....	16-17.5(2)	16-17.5 (2)
Bright Stock—*Vis. at* 210°		
200 Vis. D.....	27 (1)	27 (1)
150-160 Vis. D:		
0 to 10 p.p.....	23	23
10 to 25 p.p.....	22.5-23	22.5-23
25 to 40 p.p.....	23 (1)	23 (1)
150-160 Vis. E....	22 (1)	22 (1)
120 Vis. D:		
0 to 10 p.p.....	22 (2)	22 (2)
600 S.R. Dark Green.....	8.5 (1)	8.5 (1)
600 S.R. Olive Green.....	10-11 (2)	10-11 (2)
631 S.R.....	....	....
Black Oil.....	....	....

NOTE: Discounts of 0.5c to 1c on bright stock and 0.5c to 2c allowed for neutrals, 10 car lots, and to "meet competition." Brokers offering at greater discounts.

SOUTH TEXAS (Neutral Oils)

Pale Oils (*Vis. at* 100°*F.*)

Vis. Color		
100 No. 1½-2½.	6.5	6.5
200 No. 2-3.....	8.75	8.75
300 No. 2-3.....	9.25	9.25
500 No. 2½-3½.	10	10
750 No. 3-4.....	10.25	10.25
1200 No. 3-4.....	10.375	10.375
2000 No. 4.....	10.5	10.5

(Continued on next page)

NOTE—Parenthetical figures after prices indicate number of companies quoting when less than three companies are quoting.

NOTICE—Owing to great demand, refiners generally limit quotations to regular customers and refuse bids, though higher, from others. Refiners' prices and sales shown; bids reported in market leads

Refinery Prices (Continued)

Prices in Effect	Jan. 1	Dec. 25
Red Oils:		
100 No. 5-6	6.5 (2)	6.5 (2)
200 No. 5-6	8.75	8.75
300 No. 5-6	9.25	9.25
500 No. 5-6	10	10
750 No. 5-6	10.25	10.25
1200 No. 5-6	10.375	10.375
2000 No. 5-6	10.5	10.5

CHICAGO (From Mid-Continent p.l. crude.) Neutral oils *vis. at* 100° *F. 0 to 10 p.p.*

Pale Oils		
Vis. Color		
60-85—No. 2	9 (1)	9 (1)
86-110—No. 2	9.25 (1)	9.25 (1)
150—No. 3	12.5 (1)	12.5 (1)
180—No. 3	13 (1)	13 (1)
200—No. 3	13 (1)	13 (1)
250—No. 3	14 (1)	14 (1)
Red Oils:		
180—No. 5	13 (1)	13 (1)
200—No. 5	13 (1)	13 (1)
250—No. 5	14 (1)	14 (1)
280—No. 5	15 (1)	15 (1)
300—No. 5	15.5 (1)	15.5 (1)

Note: Viscous oils, 15 to 30 p.p. are quoted 0.5c lower; 60-85 and 86-110 No. 2 non-viscous oils, 15 to 30 p.p., 0.25c lower.

Unfiltered Steam Refined (*(Viscosity at* 210°)		
140	11.5 (1)	11.5 (1)
160	12.5 (1)	12.5 (1)
200	13.5 (1)	13.5 (1)
Bright stocks, 160 *vis. at* 210 *No.* 8 *color:*		
0 to 10 p.p.	24 (1)	24 (1)
15 to 25 p.p.	23.5 (1)	23.5 (1)
30 to 40 p.p.	21.5 (1)	21.5 (1)
E filtered Cyl. Stock	15.5 (1)	15.5 (1)

Note: To obtain prices delivered in Chicago add 0.25c per gal.

Natural Gasoline

(Group 3 & Breckenridge prices are to blenders on freight basis shown below. Shipments may originate in any Mid-Continent manufacturing district.

FOB GROUP 3

Grade 26-70 4.75 (Quote) 4.75 (Quote)

FOB BRECKENRIDGE

Grade 26-70 4.375 (Quotes) 4.375 (Quotes)

CALIFORNIA (FOB plants in Los Angeles basin)

21 pound vapor pressure for blending 4.75 - 5.375 4.75 - 5.375

Naphtha and Solvent

(*FOB Group* 3)

Stoddard solvent	6.625	6.625
Cleaners' naphtha	7.125	7.125
V.M.&P. naphtha	7.1 - 7.125	7.1 - 7.125
Mineral spirits	6.1 - 6.125	6.1 - 6.125
Rubber solvent	7.1 - 7.125	7.1 - 7.125
Lacquer diluent	7.375- 8.125	7.375- 8.125
Benzol Diluent	7.875- 8.625	7.875- 8.625

WESTERN PENNA.

Other Districts:

Untreated naphtha	7 -7.25 (2)	7 -7.25 (2)
Stoddard solvent	7.25 -7.5 (2)	7.25 -7.5 (2)

OHIO (S. O. quotations for statewide delivery):

	V.M.&P. naphtha.	D.C. naphtha, Varnolene &
Sohio solvent	10	10
Rubber solvent	9	9

Wax

WESTERN PENNA. (Bbls. C.L.)

White Crude Scale:		
122-124 A.m.p.	4.25 (2)	4.25 (2)
124-126 A.m.p.	4.25	4.25

OKLAHOMA (C.L. FOB Refinery)

Semi-refined:		
128 AMP min., white, 50 kilo bags	No Price	No Price
132-134 AMP, bbls.	5(1)	5(1)

CHICAGO (FOB Chicago district refinery of one refiner, in bags, carloads. Carloads, slabs loose, 0.4c less. Melting points are EMP (ASTM) methods; add 3° to convert into AMP.)

Fully refined:		
122-124 (bags only)	5.6	5.6
125-127	6	6
127-129	6.25	6.25
130-132	6.55	6.55
132-134	6.8	6.8
135-137	7.55	7.55

Petrolatums

WESTERN PENNA. (Bbls., carloads; tank cars, 0.5c per lb. less.)

Snow White	6.125- 7.25	6.125- 7.25
Lily White	5.375- 6.25	5.375- 6.25
Cream White	4.375- 5.5	4.375- 5.5
Light Amber	3.375- 4	3.375- 4
Amber	3.125- 3.75	3.125- 3.75
Red	3 - 3.5	3 - 3.5

Tank Wagon Prices

Commercial or consumer tank car, tank wagon, dealer, and service station prices for gasoline do not include taxes; *they do, however, include inspection fees as shown in general footnote. Gasoline taxes, shown in separate column, include 1.5c federal, and state taxes; also city and county taxes as indicated in footnotes. Kerosine tank wagon prices also do not include taxes; kerosine taxes where levied are indicated in footnotes. Dealer discounts are shown in footnotes. These prices in effect Jan. 1, 1945 as posted by principal marketing companies at their headquarters offices, but subject to later correction*

S. O. N. J.

	Esso (*Regular Grade*) Consumer Tank Wagon	Dealer T.W.	Gasoline Taxes	Kerosine T.W.
*Atlantic City, N. J.	10.2	10.7	4.5	10
*Newark, N. J.	10.2	10.7	4.5	10
Annapolis, Md.	10.55	11.05	5.5	....
Baltimore, Md.	9.95	10.45	5.5	10.8
Cumberland, Md.	11.35	11.85	5.5	12.3
Washington, D. C.	10.2	10.7	4.5	11.3
Danville, Va.	11.65	12.15	6.5	12.55
Norfolk, Va.	10.45	10.95	6.5	12.3
Petersburg, Va.	10.75	11.25	6.5	13.3
Richmond, Va.	10.75	11.25	6.5	13.3
Roanoke, Va.	11.95	12.45*	6.5	12.8
Charleston, W. Va.	11.65	12.15*	6.5	13.1
Parkersburg, W. Va.	10.95	11.45	6.5	12.8
Wheeling, W. Va.	10.95	11.45*	6.5	13.4
Charlotte, N. C.	11.70	12.20*	7.5	11.3
Hickory, N. C.	12.25	12.75	7.5	12.3
Mt. Airy, N. C.	12.10	12.6	7.5	11.5
Raleigh, N. C.	11.45	11 95	7.5	12.3
Salisbury, N. C.	11.75	12.25	7.5	12.7
Charleston, S. C.	10.55	11.05	7.5	.....
Columbia, S. C.	11.40	11.9	7.5	.....
Spartanburg, S. C.	12.1	12.6	7.5	.....

*Correct on and since Sept. 1.

	Mineral Spirits T.W.	V.M.&P. T.W.
Newark, N. J.	13	14.5
Baltimore, Md.	15.5	....
Washington, D. C.	15.5	....

uel Oils—T.W.	No. 1	No. 2	No. 3
Atlantic City, N. J.	10	9	9
Newark	10	9	9
Annapolis, Md.	..	..	..
Baltimore	9.8	9	9
Washington, D. C.	10.3	9.4	9.4
Norfolk, Va.	10	8.8	8.8
Petersburg	10.3	9	..
Richmond	10.3	9	9
Charlotte, N. C.	10.3	10.1	..
Hickory, N. C.	..	9.7	..
Raleigh	11.3	9.8	..
Charleston, S. C.	..	8.7	..
Columbia	..	9.7	..
Spartanburg	..	10.5	..

*Effective Aug. 5, '42 minimum retail resale price of 14.2c posted thru New Jersey.

Discounts:

Esso gasoline—to undivided dealers, 0.5c off dealer t.w.

Kerosine—1c off t.w. price for 25 gals. or more, under contract thru territory (Baltimore city contract not necessary) except no discount in state of New Jersey.

Naphtha—To buyers taking following quantities at one time: Newark, 2c per gal. on 200 gals. or more, less than 200 gals. 0.5c higher price; Baltimore, 2c off on 25 to 100 gals. and 3c on over 100 gals.; Washington, 2c off to contract buyers.

Notice

These prices include inspection fees on both gasoline and kerosine unless otherwise specified per gallon as follows:

Ala. 1/40c on gasoline; Ark. 1/20c; Fl. 1/8c; Ill. 3/100c; Ind. 1/5c in lots of 25 bbls. or less, 2/25c in lots of more than 25 bbls.; Kans. 1/50c; La. 1/32c; Minn. 7/200c; Miss. 1/50c; Neb. 3/100c; Nev. 1/20c; N. C. 1/4c; N. Da. 1/20c; Okla. 2/25c; S. Car. 1/8c; S. Da. 1/20c; Tenn. 2/5c; and Wisc. 3/100c.

Kerosine inspection fees only: Ala. 1/2c; Fla. 1/8c; Iowa 3/50c; Mich. 1/5c per gal.

CONT'L OIL

	†Tank Wagon	De-Brons-e-s mand (*3rd Grade*)	Gasoline Taxes	Kerosine T.W.
Denver, Col.	10	9	5.5	10
Grand Junc., Col.	12.5	11.5	5.5	12.5
Pueblo, Col.	9.5	8.5	5.5	9.5
Casper, Wyo.	11.5	10.5	5.5	12
Cheyenne, Wyo.	10	9	5.5	9
Billings, Mont.	12	11	6.5	12.5
Butte, Mont.	11.5	10.5	6.5	13.5
Great Falls, Mont.	12	11	6.5	12.5
Helena, Mont.	12	11	6.5	13
Salt Lake City, Utah	13.5	12.5	5.5	14.5
Boise, Ida.	13.6	12.6	6.5	16.5
Twin Falls, Ida.	14.6	13.6	6.5	17
Albuquerque, N. M.	10.5	9.5	*7	9.5
Roswell, N. M.	10	9	*7	7
Santa Fe, N. M.	10.5	9.5	*7.5	10
Ft. Smith, Ark.	9	6.25	*7	8
Texarkana, Ark.	9	7.5	*5.5	7
Muskogee, Okla.	7.75	6.75	7	8
Oklahoma City, Okla.	8	7	7	8
Tulsa, Okla.	8	7	7	8

*Taxes: In gasoline tax column are included these city taxes—Albuquerque, & Roswell, 0.5c, Santa Fe, 1c. Texas 4c state tax applies within city limits of Texarkana, Ark.; Okla., 5.5c state applies within city limits of Ft. Smith, Ark.

†To Consumers & Dealers.

NOTE: Current selling price—where this is lower than maximum price it is because of local competition. It is the actual selling price and is subject to revision due to delays in receiving information from the field.

S. O. NEB.

	(*Regular Grade*) T.W.	Dealer	Gasoline Taxes	Kerosine T.W.
Omaha	11.4	9.6	6.5	10.1
McCook	12.0	10.1	6.5	10.5
Norfolk	11.9	10.4	6.5	10.6
North Platte	12.2	10.6	6.5	11
Scottsbluff	12.9	10.2	6.5	10.8

S. O. CAL.

	Standard Posted Net Tank Truck	Posted Retail	Flight Posted Net Tank Truck	Posted Retail	Gasoline Taxes
	Standard Gasoline (*Regular Grade*) Flight Gasoline (*Third Grade*)				
San Francisco, Cal.	10	14	9	12	4.5
Los Angeles, Cal.	9.5	13.5	8.5	11.5	4.5
Fresno, Cal.	11	15	10	13	4.5
Phoenix, Ariz.	12	16	10	13	6.5
Reno, Nev.	12	16	11	14	5.5
Portland, Ore.	10.5	14.5	9.5	12.5	6.5
Seattle, Wash.	10.5	14.5	9.5	12.5	6.5
Spokane, Wash.	12.5	16.5	11.5	14.5	6.5
Tacoma, Wash.	10.5	14.5	9.5	12.5	6.5

	Std. Aviation 73 Posted Net Tank Truck	Gasoline Taxes	Kerosine Tank Truck
San Francisco, Cal.	12.5	4.5	11.5
Los Angeles, Cal.	12	4.5	10
Fresno, Cal.	13.5	4.5	12.5
Phoenix, Ariz.	14.5	6.5	12.5
Reno, Nev.	14.5	5.5	13.5
Portland, Ore.	13	6.5	13.8
Seattle, Wash.	13	6.5	13.8
Spokane, Wash.	16	6.5	16.8
Tacoma, Wash.	13	6.5	13.8

Resale and Commercial Gasoline: Tank car deliveries of Standard Aviation 73, Standard's Supreme and Flight Gasoline .25c per gal. below posted net tank truck price. Tank car deliveries of Standard Gasoline .375c per gal. below posted net tank truck price. Pearl Oil (The Standard Kerosene) Tank car deliveries 3c below posted tank truck price.

TEXAS CO.

	Gasoline—Dealer T.W. Fire-Chief (*Regular*)	Indian (*3rd Grade*)	Gasoline Taxes
Dallas, Tex.	7.5	6.5	5.5
Ft. Worth, Tex.	7.5	6.5	5.5
Wichita Falls, Tex.	8.5	7.5	5.5
Amarillo, Tex.	8.5	7.5	5.5
Tyler, Tex.	8.5	7.5	5.5
El Paso, Tex.	11	10.5	5.5
San Angelo, Tex.	8.5	7.5	5.5
Waco, Tex.	8.5*	7*	5.5
Austin, Tex.	8.5	7.5	5.5
Houston, Tex.	8.5	7.5	5.5
San Antonio, Tex.	8.5	7.5	5.5
Port Arthur, Tex.	8.5	7.5	5.5

*Less 1c temporary allowance to all dealers.

(Continued on next page)

Tank Wagon Prices—Continued

S. O. IND.

	Red Crown Cons. T.W.	Red Crown Dealer T.W.	Blue Crown (*Third Grade*) Dealer T.W.	Gasoline Taxes	Kerosine T.W.
Chicago, Ill.	11.6	9.6	9.1	4.5	10.6
Decatur, Ill.	11.6	9.6	8.7	4.5	10.3
Joliet, Ill.	11.9	10.3	9.2	4.5	10.6
Peoria, Ill.	11.7	9.9	9.7	4.5	10.4
Indianapolis, Ind.	11.6	10.1	9.6	5.5	10.1
Evansville, Ind.	11.4	9.9	8.6	5.5	9.9
South Bend, Ind.	12	10.5	10	5.5	10.5
Detroit, Mich.	11.4	9.9	9.4	4.5	10
Grand Rapids, Mich.	11.4	9.9	9.4	4.5	9.9
Saginaw, Mich.	11.4	9.9	9.4	4.5	9.9
Green Bay, Wis.	12.2	10.7	10.2	5.5	10.9
Milwaukee, Wis.	12.1	10.6	10.1	5.5	10.8
La Crosse, Wis.	11.9	10.4	9.9	5.5	10.6
Minneapolis - St. Paul.	11.9	10.4	9.9	5.5	10.6
Duluth, Minn.	12.2	10.7	10.2	5.5	10.9
Mankato, Minn.	11.9	10.4	9.9	5.5	10.6
Des Moines, Ia.	11.4	9.9	9.4	4.5	*10.1
Mason City, Ia.	11.7	10.2	9.7	4.5	*10.4
St. Louis, Mo.	11.0	9.5	9.3	*4.5	10.1
Kansas City, Mo.	11.0	9.5	8.6	*4.5	9.7
St. Joseph, Mo.	11.2	9.7	9.2	*4.5	9.9
Fargo, N. D.	12.9	11.4	10.9	5.5	11.6
Huron, S. D.	12.3	10.8	10.3	5.5	11
Wichita, Kans.	10.3	8.8	7.2	4.5	9.0

(Prices are base prices before discounts)

	Oleum Spirits	V.M.&P. Naphtha	Stanisol	*Taxes
Chicago	13.5	13.8	12.8	4.5
Detroit	15.8	15	16.3	4.5
E. C., Mo.	13.3	14.3	13.8	1.5
St. Louis, Mo.	13.7	14.7	13.2	1.5
Milwaukee	14.4	15.4	14.9	5.5
Minneap'lis	14.2	15.2	13 5	5.5

Fuel Oils T.W. Chicago

	Standard Heater Oil	Stanolex Furnace Oil
1-99 gals.	9.3	8.8
100-149 gals.	8.3	7.8
150 gals. & over	7.8	...
150-399 gals.	...	7.8
400 gals. & over	...	7.3

	Stanolex Fuel A	Stanolex Fuel C
1-749 gals.	6.5	6.0
750 gals. & over	5.75	5.25

Stanolex Furnace Oil

Other Points	1-99 gals.	100 gals. & over
Indianapolis	9.0	8.0
Detroit	8.7	7.7
Milwaukee	9.0	8.0
Minneapolis	9.1	8.1
St. Louis	8.4	7.4
Kansas City	8.1	7.1

*Taxes: In gasoline tax column are included these city taxes—Kansas City, St. Joseph and St. Louis, 1c. Iowa kerosine prices are ex 3c state tax. In naphtha tax column are included 1.5c federal tax and state taxes.

State sales, occupation, consumer and use taxes to be added when applicable.

S. O. LA.

	Esso Gasoline (*Regular Grade*) Consumer Tank Wagon	Dealer T.W.	Gasoline Taxes	Kerosine T.W.
New Orleans, La.	8.75	9.25	8.5	*9
Baton Rouge, La.	8.75	9.25	8.5	*9.5
Alexandria, La.	8.75	9.25	8.5	*9.5
Lafayette, La.	9	9.5	8.5	*9
Lake Charles, La.	9	9.5	8.5	*11
Shreveport, La.	8.5	9	8.5	*8
Knoxville, Tenn.	10.5	11	8.5	12.5
Memphis, Tenn.	8.90	9.40	8.5	10.5
Chattanooga, Tenn.	10.5	11	8.5	11
Nashville, Tenn.	10.5	11	8.5	10
Bristol, Tenn.	10.95	11.45	8.5	13.1
Little Rock, Ark.	9.5	10	8	10

*Louisiana kerosine prices are ex 1c state tax

Discounts:

Esso Gasoline—To undivided dealers, 0.5c off dealer t.w.

S. O. OHIO

	*Sohio X-70 Gasoline (*Regular Grade*) Consumer T.W.	**Resellers	‡S.S.	Gasoline Taxes	†Kerosine T.W.
Ohio, Statewide	12	10	13.5	5.5	9.3
Akron	12	9.5	12.5	5.5	9.3
Canton	12	9.5	12.5	5.5	9.3
Cincinnati	12	9.5	12.5	5.5	9.3
Cleveland	12	9.5	12.5	5.5	9.3
Columbus	12	9.5	12.5	5.5	9.3
Dayton	12	9.5	12.5	5.5	9.3
Lima	12	9.5	12.5	5.5	9.3
Mansfield	12	9.5	12.5	5.5	9.3
Marion	12	9.0	12.0	5.5	9.3
Portsmouth	12	9.5	12.5	5.5	9.3
Toledo	12	9.5	12.5	5.5	9.3
Youngstown	12	9.5	12.5	5.5	9.3
Zanesville	12	9.5	12.5	5.5	9.3

Aviation Gasoline—Statewide

	Consumer T.W.	Gasoline Taxes
Sohio Aviation Gasoline clear Spec. AN-F-22	14.5	5.5
Esso Ethyl Aviation 73 Oct.	15.5	5.5
Esso Ethyl Aviation 80 Oct.	16.5	5.5
Esso Ethyl Aviation 91 Oct.	17.5	5.5
Esso Ethyl Aviation 100 Oct.	24.5	5.5

	†Naphtha—T.W. Statewide	Lucas County
S. R. Solvent	13.5	13.5
D. C. Naphtha	14.5	14.25
V.M.&P. Naphtha	14.5	14.25
Varnolene	14.5	14.25
Sohio Solvent	14.5	14.25

Fuel Oils—T.W.	No. 1	No. 2	No. 3	No. 4
Ohio, Statewide	8.3	8.3	7.8	*7.55

*Renown (third-grade) prices are same as X-70 unless otherwise noted.

**Except authorized agents.

†Kerosine prices are ex 1c state tax. Naphtha prices are ex 1.5c federal & 4c state tax.

‡Prices at company-operated stations.

††Statewide prices are subject to exceptions other than those shown.

Discounts:

Esso aviation—on contract to hangar operators and resellers, 2c off consumer t.w.

*For Cleveland area only. Full compartment hose dumps.

Fuel oils—Statewide prices are for t.w. & drum deliveries of 50 gals. or more; prices for deliveries of less than 50 gals. are 0.5c higher.

Naphthas—to contract consumers off t.w. prices—Statewide: 300 to 999 gals., 0.5c; 1000 to 2499 gals., 0.75c; 2500 to 4999 gals., 1c; 5000 or more gals., 1.5c. Lucas County: Less than 50 gals., tank wagon price, 50 to 249 gals., 0.5c; 250 to 499 gals., 1c; 500 gals. or over, 1.5c.

HUMBLE OIL

	Humble *Tank Wagon	Humble Retail	Thriftane (*Third Grade*) *Tank Wagon	Thriftane Retail	Gasoline Taxes
Dallas, Tex.	7.5	10.5	6.5	10.5	5.5
Ft. Worth, Tex.	6.5	9.5	6	7.5	5.5
Houston, Tex.	8.5	12.5	7.5	10.5	5.5
San Ant., Tex.	8 5	12.5	7.5	10.5	5.5

Consumer tank wagan prices are 1c per gal. above the dealer tank wagon prices.

	Kerosine *Tank Wagon	Retail
Dallas, Tex.	7	10
Ft. Worth, Tex.	7	11
Houston, Tex.	8	11
San Antonio, Tex.	7	10

*To all classes of dealers & consumers

Canada

PRICES OF IMPERIAL OIL, LTD.

Per Imperial Ga , which is 1.2 U. S. Gallons

IMPERIAL OIL

	3-Star Imperial Gasoline (*Regular Grade*) †Gasoline T.W.	*Gasoline Taxes	Kerosine T.W.
Hamilton, Ont.	16.5	11	18
Toronto, Ont.	16.5	11	18
Brandon, Man.	20.5	10	23
Winnipeg, Man.	20.0	10	22.5
Regina, Sask.	17.5	10	20
Saskatoon, Sask.	20.3	10	22.8
Edmonton, Alta.	18.4	10	20.9
Calgary, Alta.	15.5	10	18
Vancouver, B. C.	15	10	24
Montreal, Que.	16.5	11	17.5
St. John, N. B.	16	13	19
Halifax, N. S.	16	13	19

*Includes 3c Federal, and Provincial taxes.

†To divided & undivided dealers

Absorption Gasoline—No. 26 R V.P.—$2.28

Gasoline prices effective Oct. 7.

ATLANTIC REFINING

	Atlantic White Flash (*Regular Grade*) Commercial T.W.	Dealer T.W.	Gasoline Taxes	Kerosine T.W.
Philadelphia, Pa.	10.2	10.7	5.5	12.25
Pittsburgh	10.1	10.6	5.5	12.1
Allentown	10.7	11.2	5.5	12.6
Erie	10.1	10.6	5.5	12.1
Scranton	10.7	11.2	5.5	12.6
Altoona	10.7	11.2	5.5	12.6
Emporium	10.1	10.6	5.5	12.1
Indiana	10.7	11.2	5.5	12.6
Uniontown	10.1	10.6	5.5	12.1
Harrisburg	10.7	11.2	5.5	12.6
Williamsport	10.7	11.2	5.5	12.6
Dover, Del.	....	11.2	5.5	12.6
Wilmington, Del.	....	10.7	5.5	12.1
Boston, Mass.	....	10.9	4.5	....
Springfield, Mass.	....	11.8	4.5	....
Worcester, Mass.	....	11.5	4.5	....
Fall River, Mass.	....	11	4.5	....
Hartford, Conn.	....	11.6	4.5	....
New Haven, Conn	....	11	4.5	....
Providence, R. I.	....	11	4.5	....
Atlantic City, N. J.	....	10.7	4.5	10
Camden, N. J.	....	10.7	4.5	10
Trenton, N. J.	....	10.7	4.5	10
Annapolis, Md.	....	11.05	5.5	10.8
Baltimore, Md.	....	10.45	5.5	9.8
Hagerstown, Md.	....	11.55	5.5	10.8
Richmond, Va.	....	11.25	6.5	12.8
Wilmington, N. C.	....	11.15	7.5	11.6
Brunswick, Ga.	....	10.1	7.5	10.6
Jacksonville, Fla.	....	10.1	8.5	11.6

	Mineral Spirits T.W.†	V.M.&P. T.W.†
Philadelphia, Pa.	11	12.5
Lancaster, Pa.	12	13.5
Pittsburgh, Pa.	12.5	13.5

	Fuel Oils—T.W. 1	2	3	5	6
Phila., Pa.	10.1	9	9	5.76	5.04
Allentown, Pa.	10.6	9.3	9.3	....	....
Wilmington, Del.	10.1	9	9	....	....
Springfield, Mass.	10.2	9.4	9.4	....	....
Worcester, Mass.	10.2	9.3	9.3	....	....
Hartford, Conn.	10.5	9.2	9.2	....	....

‡Does not include 1c Georgia kerosine tax.

†Mineral Spirits prices also apply to Stoddard Solvent; V.M.&P. prices also apply to Light Cleaners Naphtha.

Discounts:

Gasoline—to undivided dealers, 0.5c off dealer t.w. except Georgia & Florida dealer t.w. and undivided dealer t.w. prices are same.

Kerosine—Thru Penna. & Delaware, 2c off t.w. price on t.w. deliveries of 25 gals. or more at one time.

S. O. KY.

	Crown Gasoline (*Regular*) Standard (*Third Grade*) †Net Crown	Gasoline Taxes	Kerosine T.W.
Covington, Ky.	9.5	6.5	9.8
Lexington, Ky.	10.5	6.5	9.8
Louisville, Ky.	10	6.5	8.8
Paducah, Ky.	10	6.5	8.8
Jackson, Miss.	10	7.5	*9
Vicksburg, Miss.	9.5	7.5	*8.5
Birmingham, Ala.	10	*8.5	9
Mobile, Ala.	9	*9.5	8.5
Montgomery, Ala.	10	*9.5	*10
Atlanta, Ga.	11	7.5	*11.6
Augusta, Ga.	11	7.5	*11.1
Macon, Ga.	11	7.5	*11.6
Savannah, Ga.	10	7.5	*10.6
Jacksonville, Fla.	10	8.5	9.6
Miami, Fla.	10	8.5	9.6
Pensacola, Fla.	9	*9.5	8
Tampa, Fla.	10.1	8.5	9.6

*Taxes: In tax column are included these city and county gasoline taxes: Mobile, 2c city; Birmingham, 1c city, Montgomery, 1c city and 1c county; Pensacola, 1c city. Georgia and Montgomery, Ala. have 1c kerosine tax, Mississippi 0.5c, included in above prices.

†Consumer t.w. prices are same as net dealer prices.

SOCONY VACUUM

	Socony Mobilgas (*Regular Grade*) Com. Cons. T.W.	Undiv. Dlr. T.W.	Gasoline Taxes
New York City			
Manhattan & Bronx	10.1	10.6	*5.5
Kings & Queens	10.1	10.6	*5.5
Richmond	9.7	10.2	*5.5
Albany, N. Y.	9.9	10.4	5.5
Binghamton, N. Y.	11	11.5	5.5
Buffalo	9.6	10.1	5.5
Jamestown, N. Y.	9.8	10.3	5.5
Mt. Vernon, N. Y.	10.1	10.6	5.5
Plattsburg, N. Y.	11	11.5	5.5
Rochester, N. Y.	10.8	11.3	5.5
Syracuse, N. Y.	10.5	11	5.5
Bridgeport, Conn.	10	10.5	4.5
Danbury, Conn.	10.5	11	4.5
Hartford, Conn.	10.6	11.1	4.5
New Haven, Conn.	10	10.5	4.5

(Continued on next page)

Atlantic Coast

(Prices are of refiners, FOB their refineries & their tanker terminals, & of tanker terminal operators FOB their terminals)—Prices in Effect Jan. 1.

MOTOR GASOLINE

District	72 Oct. (ASTM)	70-74 oct. (ASTM)
N. Y. Harb.	Not made	9.075
N. Y. Harb., barges	"	8.975
Albany	"	9.175
Philadelphia	"	9.075
Baltimore	"	8.825
Norfolk	"	8.575
Wilmington, N. C.	"	8.175
Charleston	"	8.175
Savannah	"	7.845
Jacksonville	"	7.845
Miami	"	7.845
Tampa	"	7.845
Pensacola	"	6.875 (1)
Mobile	"	6.62 – 6.745
New Orleans	"	6.125(1)
Portland	"	9.375
Boston	"	9.275
Providence	"	9.275

FUEL OILS

District	KEROSINE and/or NO. 1 FUEL	No. 2	No. 3	No. 5	No. 6
N. Y. Harb.	7.1	6.7	6.7	$1.85–$1.95 (a)	$1.77
N. Y. Harb., barges	7	6.6	6.6	....	....
Albany	7.3	6.8	6.8 (2)	....	$1.97 (1)
Philadelphia	7.2	6.7	6.7	$1.98	$1.77
Baltimore	7.2	6.7	6.7	$1.85 (1)	$1.77
Norfolk	7.1	6.7	6.7 (1)	$1.85 (1)	$1.77
Wilmington, N. C.	6.75	6.4	....	....	....
Charleston	6.9	6.4 (2)	....	$1.80 (1)	$1.72 (2)
Savannah	6.55	5.75 (1)	....	....	$1.72 (1)
Jacksonville	6.55	5.75	....	....	$1.72
Miami	6.55	5.75 (1)	....	....	....
Tampa	6.55	5.75	....	....	$1.62
Pensacola	4.8 (1)	....	....	....	....
Mobile	4.75 (2)	....	....	....	....
New Orleans	4.125–4.25 (2)	3.75 (2)	....	$1.27 (1)	$0.97
Portland	7.3	6.8	6.8 (2)	....	$1.77
Boston	7.2	6.7	6.7 (2)	$1.95 (2)	$1.77
Providence	7.2	6.7	6.7 (2)	$1.90 (1)	$1.77

(a) Price is for straight-run low pour, test No. 5 ($1.95)

Pacific Export

In Ship's Bunkers, or deep tank lots:

Prices in Effect	Jan. 1	Dec. 25
Diesel Fuel, Pac. Spec. 200	$1.45	$1.45
Grade C fuel, Pac. Spec. 400	$1.10	$1.10

Seaboard Export Coastwise Prices

Tank Wagon Prices (Continued)

SOCONY VACUUM

	Socony Mobilgas (*Regular Grade*) Com. Cons. T.W.	Undiv. Dlr. T.W.	Gasoline Taxes
Bangor, Me.	10.7	11.2	5.5
Portland, Me.	10.3	10.8	5.5
Boston, Mass.	9.9	10.4	4.5
Concord, N. H.	11.4	11.9	5.5
Lancaster, N. H.	12	12.5	5.5
Manchester, N. H.	11.3	11.8	5.5
Providence, R. I.	10	10.5	4.5
Burlington, Vt.	10.9	11.4	5.5
Rutland, Vt.	11	11.5	5.5

	Mineral Spirits T.W.	V.M.&P. T.W.
Buffalo, N. Y.	12.4	13.6
New York City	11	12
Rochester, N. Y.	13.2	14.4
Syracuse, N. Y.	14	....
Boston, Mass.	12	13
Bridgeport, Conn	†16.3	†17.3
Hartford, Conn.	†16.3	†17.3
Providence, R. I.	13	14

	Kerosine Yard	Kerosine T.W.	Mobilfuel Diesel T.C.	Mobilfuel Diesel T.W	Mobilheat Fuel Yard	Mobilheat Fuel T.W.
New York:						
Manhat'n & Bronx	7.5	10.3	...	9.3	7.1	9
Kings & Queens	7.5	10.3	...	9.3	7.1	9
Richmond	7.5	10.3	...	...	7.1	9.0
Albany	7.5	9.8	6.8	9.3	7	9
Binghamton	8.9	11.2	...	10.7	8.4	10.2
Buffalo	8.1	10.4	7.5	9.8	7.7	9.5
Jamestown	8.2	10.5	...	10.1	7.8	9.5
Mt. Vernon	7.6	10.3	...	9.4	7.2	9
Plattsburg	8.1	10.4	...	9.9	7.6	9.4
Rochester	8.7	11	7.9	10.2	7.9	9.7
Syracuse	8.5	10.8	7.8	10.1	7.8	9.6
Conn.:						
Bridgeport	7.8	10.3	...	....	7.3	9.0
Danbury	8.2	10.8	...	....	7.8	8.5
Hartford	8.0	10.5	...	9.5	7.4	9.2
New Haven	7.5	10.3	...	9.3	7.1	9.0
Maine:						
Bangor	7.9	10.2	7.4	9.7	7.4	9.1
Portland	7.5	10.2	6.8	9.3	7	9
Mass.:						
Boston	7.8	10.6	6.7	9.2	7.1	9
N. H.:						
Concord	8.4	10.7	...	....	8.2	10
Lancaster	9.5	11.8	...	....	9.2	11
Manchester	8.5	11.1	...	....	7.9	9.7
R. I.:						
Providence	7.8	10.1	6.7	9.2	7.1	9.0
Vermont:						
Burlington	8.1	10.4	7.5	9.8	7.5	9.2
Rutland	8.3	10.6	...	10	7.7	9.5

*Does not include 1% city sales tax applicable to price of gasoline (ex tax).

†In steel barrels.

Discounts: Diesel—On t.w. deliveries, 0.5c for at least 400 gals.; 1c for full tank truck.

EXPORT PRICES

Prices Effective Jan. 1

	Mexican Gulf Ports U. S. Dollars per Bbl. Bunker C	Diesel
Tampico	$0.97	$1.65
Veracruz	0.97	....
Coatzacoalcos	0.97	1.65
	Pacific Coast	
Guaymas	$1.50	$3.22
Mazatlan	1.50	3.22
Acapulco	1.50	2.89
Manzanillo	1.50	2.89
Salina Cruz	1.50	2.89

	Bunker C Fuel Ships' bunkers (Ex Lighterage)	Diesel Oil Ships' bunkers (Ex Lighterage)	Diesel Oil Shore Plants	Gas House Gas Oil 28-34 Gravity
New Haven	$1.77	.....	.....	.....
N. Y. Harbor	$1.77	$2.78	6.7	6.8 (2)
Albany	$1.97 (1)	$2.94 (1)	6.8 (1)	7 (1)
Philadelphia	$1.77	$2.78	....	....
Baltimore	$1.77	$2.78	6.7 (1)	6.7 (1)
Norfolk	$1.77	$2.78	6.7 (1)	6.7 (1)
Charleston	$1.72 (2)	$2.65 (1)	6.4 (1)	6.4 (1)
Savannah	$1.72 (1)	$2.52 (1)	....	....
Jacksonville	$1.72	$2.41 (2)	....	....
Tampa	$1.62	$2.41 (2)	....	....
New Orleans	$0.97	$1.65 (1)	4 (1)	....
Portland	$1.77	.....	6.8 (1)	6.9 (1)
Boston	$1.77	$2.78	6.7 (2)	6.8 (2)
Providence	$1.77	$2.78 (2)	6.7 (1)	6.8 (1)

Bunker "C" when from Navy storage at New York and Norfolk to out-going vessels .05c discount.

Gulf Coast

Prices in Effect Jan. 1

MOTOR GASOLINE	New Orleans & Lower Mississippi to Baton Rouge Tank Cars	New Orleans & Lower Mississippi to Baton Rouge Barges	Texas Gulf Coast South of New Orleans Tank Cars	Texas Gulf Coast South of New Orleans Barges	CARGOES Domestic & Export From all Gulf Ports
Leaded (oct. by ASTM)					
76 oct.	6.75	6.5	6.5 – 6.75	6.75	6.75
70-74 oct.	6 – 6.125	5.625	5.625–6.375 (a)	5.625	5.625
63-65 oct.	....	....	....	....	....
Unleaded 70 oct.	....	....	....	....	5.625
67-68 oct.	....	....	....	....	....
65 oct.	....	....	....	....	5.25
60 oct.	....	....	....	....	5
KEROSINE & LIGHT FUELS					
41-43 w.w. kero.	4.125– 4.25	4.125	4.125– 4.25	4.125	4.125
42-44 w.w. kero.	....	....	4.125	4.125	4.125
No. 2 fuel oil	3.75	3.75	3.75 – 4	3.75	3.75
DIESEL & GAS OILS					
(In diesel index No.)					
Below 43 di.	....	....	....	....	....
43-47 di.	....	....	....	....	4
48-52 di.	4	4	4	....	4
53-57 di.	4.125	....	4.125	4.125	4.125
58 and above	4.25	....	4.25	....	4.25

(a) 5.625c for Dist. 1 and 5.875–6.375c for other districts.

NOTE: Above products in Truck Transports of 2,400 gal. and over ½c above Tank Car Prices.

Heavy Fuels & Bunker Oil (at all Gulf Ports) Heavy Diesels	In Cargoes	In Ship's Bunkers (Ex Lighterage)
Below 28 API Grav.	....	$1.35
28 & above API Grav.	....	$1.65
Bunker C Oil	$0.97	$0.97

Mid-Continent Lubes

(At Gulf; in packages, FAS.; in bulk, FOB terminals).

Prices in Effect Jan. 1

	Steel Drums	Bulk
Bright Stock		
D color, V is at 210°		
200 vis.	....	....
150 vis., 0-10 p.p.	32.65 (1&a)	24.8 (1)
100 vis., 0-10 p.p.	....	....
100 vis., 10-25 p.p.	....	....
Neutral—No. 3 color		
200 vis., 0-10 p.p.	....	--

(A) FAS at New Orleans.

Wax

(Melting points are AMP, 3° higher than EMP. Prices are FOB refinery and do not include bag, freight or export differentials).

Prices in Effect Jan. 1

Crude Scale	New Orleans Export	N. Y. Domestic	N. Y. Export
124-6 Yellow	4.25(1)	....	4.25(1)
122-4 White	....	4.25(2)	4.25(2)
124-6 White	4.25(1)	4.25	4.25
Fully Refined:			
123-5	5.2(1)	5.2(2)	5.2(1)
125-7	5.2(1)	5.2(2)	5.2(1)
128-30	5.6(1)	5.6	5.6(1)
130-32	5.85(1)	5.85(2)	5.85(1)
133-5	6.15(1)	6.15	6.15(1)
135-7	6.4(1)	6.4(1)	6.4(1)

Naphtha

Prices in Effect Jan. 1

	V.M.&P. Naphtha	Mineral Spirits
New York Harbor	11 (2)	10
Philadelphia	11 (2)	10
Baltimore	10.5 (2)	9.5
Boston	11.5 (2)	10.5
Providence	11.5 (1)	10.5 (2)

CLASSIFIED

For Sale

FOR SALE—Large garage carrying Ford agency for 30 years, storage 60 cars. Recapping plant, three molds, three vulcanizers, all doing nice business. Large repair shop, paint and body room. Large home all heated, established 1909. Located on U. S. Highway, running North and South, 150 miles from Washington, D. C. Box No. 507.

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Chanute, Kansas

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R. C. STANHOPE, INC.,
60 East 42nd St., New York 17, N. Y.

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Empire Equipment Corporation
608 Empire Bldg., Cleveland 14, Ohio
Phone Main 7667

FOR SALE
New and Reconditioned
IRON and STEEL
VALVES
Tested and Guaranteed
Also Fittings
APEX IRON & METAL CO.
2204 South Laflin St.
Chicago 8, Illinois

FOR SALE

1—4100 gallon, 2 compartment semi-tank trailer with White Tractor, new motor.

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P.O. Box 10, Mishawaka, Ind.
Phone: 5-1600

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1136 W. North Ave., Baltimore 17, Md.

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ABOUT OIL PEOPLE

New officers of the Petroleum Club of the Cleveland Chamber of Commerce, elected Jan. 2 by the board of directors, are: President **Lester S. Auerbach,** District Manager, Gulf Refining Co.; first vice president, **R. D. Kizer,** Division Manager for Shell Oil Co.; second vice president, **Roy D. Packard,** Division Manager for Standard Oil Co. of Ohio; secretary-treasurer, **Stanley B. Cofall,** president, National Solvent Corp. Mr. Cofall was re-elected.

The new officers will take over at the club's monthly luncheon meeting on Jan. 10 at the Mid-Day Club in Cleveland. At that time, Walter J. McCarter, general manager of the Cleveland Transit Co. will talk on "Programs—Immediate and Long Range for Metropolitan Cleveland".

New directors to be introduced will be **R. S. Blazer,** vice president, Allied Oil Co.; **George J. Spellman,** general agent, Sinclair Refining Co., and **R. D. Kizer** (re-elected).

° ° °

Ralph B. Lloyd, president of Lloyd Corp., Ltd., Los Angeles, last week was re-elected president of the California Oil and Gas Assn. Elected vice presidents were **William Reinhardt,** vice president, Union Pacific Railroad Co., and **C. A. Johnson,** president, Holly Development Co. **John B. Sutherland,** division manager, Ohio Oil Co. was named treasurer. Other officers are **Don E. Gilman,** executive vice president; **D. S. Kilgour,** secretary, and **George Prussing,** technical secretary.

° ° °

R. V. Hyatt, editor of *The Bulletin,* published by the Kansas Oil Men's Assn., is proud and jealous of his state. When a poor, innocent, hard-working gremlin in our editorial room changed copy reading "Dodge City, Kans." to "Dodge City, Ia.", he rolled up his sleeves, and got NPN told right up in the front part of his publication. Said Mr. Hyatt:

Our Version Of "Lassie, Come Home"

"In the Dec. 4 issue of *The Bulletin,* we printed a squib about Ralph McCoy (The Real McCoy) being commissioned a lieutenant (jg) in the Navy. We lifted the item out of *Sovereign Scroll,* and credited it as such.

"In the Dec. 6 issue of NPN, the item appeared in "About Oil People" . . . but the location was given as "Dodge City, Ia." and the source of information unidentified.

"We're reminded of the story told on William Allen White, late Emporia editor and publisher. Bill was guest at a banquet, and one of the speakers quipped about a little Iowa girl, whose family was moving to Kansas, going out into the garden, looking up at the sky, and saying: 'Goodbye, God, we're going to Kansas.' Bill got up and said: 'That's a pretty good story, but the punctuation and emphasis were not right. What the little girl really said was: 'Good! By God, we're going to Kansas!'

"Dodge City, come h-o-m-e!"

° ° °

LeRoi P. Buzette, secretary of the Detroit Oil Men's Club, has announced the resumption of the club's regular Tuesday luncheons at the Club headquarters, Detroit-Leland Hotel.

Profile in Oil

Youthful Gardiner Symonds Tiffs With Texans Over Gas

HEAD OF THE FIRM which is creating a commotion in Texas political circles is Gardiner Symonds, youthful president of the Tennessee Gas & Transmission Co.

Although millions of cubic feet of natural gas daily have been piped out of Texas to other states for the last 10 years, it was not until Tennessee received a permit to build a 24-in. line from South Texas to West Virginia that some Texas interests began raising the cry that the Yankees were draining Texas of her resources. Politicians seized upon the occasion as one offering vote appeal, and Tennessee officials have been appearing before various investigators ever since.

The company points out that as a matter of fact, the line was ordered by the Federal Power Commission and the War Production Board to supply power to the war industries in the Appalachian area, and that it is as much of a war industry as any munitions plant.

Latest development is the company announcement that it will soon take substantial amounts of waste gas now being flared in the oil fields along its 360-mile path through the Lone Star State. The amount of this gas being flared is estimated at 200,000,000 cubic feet daily, approximately that of the line's capacity.

Mr. Symonds has headed Tennessee ever since it was purchased by the Chicago Corp. in September, 1943, and he had charge of construction of

Gardiner Symonds

the $54,000,000 artery, which was pumping gas three days less than 11 months after construction was started.

Born in Pittsburgh on Oct. 15, 1903, Mr. Symonds grew up in Chicago, where his father was a vice-president for Westinghouse. He won a competitive War Memorial Scholarship to Stanford University where he majored in geology. He followed this with work at the Harvard Graduate School of Business Administration where he won his M-BA with distinction.

On graduation he went to work for the Illinois Merchants' Trust Co. in Chicago. In 1930 he went to the Chicago Corp., an investment trust identified with the bank, as assistant treasurer. He was made a vice-president in 1932 at the age of 29.

Since 1938, when Chicago Corp. teamed with Clyde Alexander in building the first commercial recycling plant, Mr. Symonds has headed the rapidly growing oil and gas operations of the company which have grown from $500,000 to $13,000,000 in six years. Chicago Corp. accounts for about 10 per cent of the capacity of the recycling industry.

Mr. Symonds is a member of the American Assn. of Petroleum Geologists and of A.P.I.

In addition to his offices with Tennessee Gas and Chicago Corp., Mr. Symonds is also a director of General Telephone Corp., Stewart-Warner Corp., Fort Dearborn Mortgage Co., and Gulf Plains Corp.

Three members of the Soviet Government Purchasing Commission recently toured the Frontier Refining Co.'s aviation gasoline plant in Cheyenne, Wyo. They were accompanied by representatives of Universal Oil Products Co., designers of the plant. Included in the tour were: **L. A. Mekler** and **M. Schrein,** U.O.P. representatives; **G. S. Kusiatin, A. P. Arefiev,** and **B. I. Bonderenko,** members of the commission. Other recent visitors to the plant included a Canadian-British delegation representing the British-American Oil Co., Ltd., Toronto, Ont., consisting of **M. S. Beringer,** assistant manager of refineries, and **J. K. Jamieson.**

° ° °

Richard C. Sauer, who resigned recently as assistant director of the PAW Supply and Transportation to return to Ohio Standard, is the recipient of a special certificate attesting the "esteem and appreciation" of his former associates for valued service as chairman of the PAW Operating Subcommittee, which develops the basic data on which PAW policies are founded. Signed by each of his colleagues on both the subcommittee and the top policy-making Operating Committee, it reads as follows:

"Upon the retirement as Chairman of the Operating Subcommittee of Mr. Richard C. Sauer, the Operating Committee and the Operating Subcommittee of the Petroleum Administration for War hereby record their esteem and appreciation of his untiring and faithful service and counsel which contributed greatly to the successful operation of both Committees, for his thorough analysis and careful judgment of all problems brought before the Committees, for his serious and effective direction of the work of the Operating Subcommittee, and for his kindly and considerate personal qualities."

° ° °

W. W. Wells, secretary of the Product Conservation Committee of the Petroleum Industry War Council and promotion manager of the industry's campaign against the Black Market, has resigned to resume business in the advertising and public relations field.

° ° °

H. T. Holland, formerly with the MacMillan Petroleum Corp. at El Dorado, Ark., has joined Calumet Refining Co., Chicago, as sales representative for the Wisconsin area.

° ° °

V. E. Liles, administrative co-ordinator of Stanolind Oil and Gas Co., Tulsa, has been elected a director of the company to replace the late **A. M. McCorkle.** Mr. Liles has been associated with the company since its formation in 1930, coming to Stanolind from the Dixie Oil Co., which was absorbed by Stanolind.

° ° °

Socony-Vacuum Oil Co., Inc. last week announced two new appointments: **W. H. Zabriskie** as manager of the industrial relations department, and **Parker S. Wise** as supervisor of the harbor and inland waterway division. Mr. Zabriskie, who has been with Socony-Vacuum for 30 years, succeeds **C. R. Dooley,** who has retired.

Mr. Wise, succeeding **Charles E. Heyle,** who is retiring after 42 years of service, joined the company's marine department in 1929.

° ° °

Notification of the death of their son, **Donald Robert,** 21, from wounds received in action in Germany on Dec. 1 has been received by **Mr. and Mrs. Frank H. Higgins,** of Rockville, Md., where Mr. Higgins is a distributor for the Sinclair Refining Co. Prior to his induction last March, Pfc. Higgins worked with his father. He was a graduate of the Augusta Military Academy, Augusta, Va., and besides his parents is survived by his wife and a four-months old son, Frank Higgins II.

° ° °

J. A. Miller

R. M. Gray

J. A. Miller, formerly advertising-sales promotion manager of the Esso Marketers, has been appointed to the newly created position of co-ordinating the domestic and foreign advertising and sales promotion activities of Standard Oil Co. (N. J.)

He was previously associated with Harrison Phelps Advertising Agency, Lee Anderson Advertising Inc. and Advertisers, Inc. He joined Esso Marketers in 1934.

R. M. Gray, who has been assistant manager of advertising-sales promotion, was named to head that department of Esso Marketers, comprising the Standard Oil Co. of New Jersey, Standard Oil Co. of Pennsylvania and the Colonial-Beacon Oil Co., operating from Maine to Louisiana.

Mr. Gray was formerly with Batten, Durstine & Osborne, Inc. in Chicago and New York. He joined Esso Marketers in 1934 and became assistant manager of the advertising-sales promotion dept. in 1942. He has also been chairman of the advertising sub-committee, PAW, Dist. 1, for more than two years.

° ° °

Riche H. Johnson, assistant comptroller of the Socony-Vacuum Oil Co., New York City, has been appointed chairman on the Committee on Co-operation with the Securities and Exchange Commission of the Controllers Institute of America.

G. F. Gephart, assistant comptroller of Standard of California, has been upped to comptroller, a position which had been held by **B. W. Letcher,** who is also a vice president and secretary of the company.

° ° °

Joseph Jensen, chief petroleum engineer for the Tide Water Associated Oil Co., last week resigned as a member of the board of commissioners of the Los Angeles Department of Water and Power.

° ° °

Opening of North Texas divisional geological offices at Wichita Falls has been announced by the Standard Oil Co. of Texas. **Jimmy Gibbs** will be the geologist in charge, assisted by **Bob Drake.**

° ° °

Back on the job as New Mexico scout for the Humble Oil & Refining Co. is **Ralph J. Hickman,** who has just been discharged from the glider training program of the Army Air Forces. He will relieve **S. S. (Si) Stinson,** Humble division scout chief, who will act as scouting supervisor from the division office at Midland, Texas.

° ° °

L. F. Wickser, who spent the past year in Alaska for Standard of California, is telling some tall tales of the Far North. He recently returned to his home in Long Beach (Calif.).

° ° °

Oscar Howard, prominent Los Angeles Basin oil producer, is up and around after a few months illness.

° ° °

Donald H. Beisel, manager of the industrial department of Wadhams Division, Socony-Vacuum Oil Co., has been promoted to a staff position at Socony-Vacuum headquarters in New York. He becomes a member of the staff of **C. E. Arnott,** vice president and director of Socony-Vacuum.

Mr. Beisel

Mr. Beisel's new duties will be concerned with industrial sales and activities in the Middle West divisions of the company.

Mr. Beisel, who graduated from Purdue University in 1920, also attended Howe Military Academy. He entered the oil business in 1920. His first position was a year's tour of duty in Japan for Standard Oil Co. of New York. He started work for Vacuum Oil Co. in 1923, as a salesman in Chicago. In 1929 he was transferred to Milwaukee as manager of the Industrial department for Vacuum Oil Co., and in 1931 became industrial manager of the combined organization of Vacuum Oil Co. and Wadhams Oil Co.

NATIONAL PETROLEUM NEWS

Monthly Technical Section Devoted to

REFINERY MANAGEMENT *and* PETROLEUM CHEMICAL TECHNOLOGY

TECHNOLOGY DEPT.

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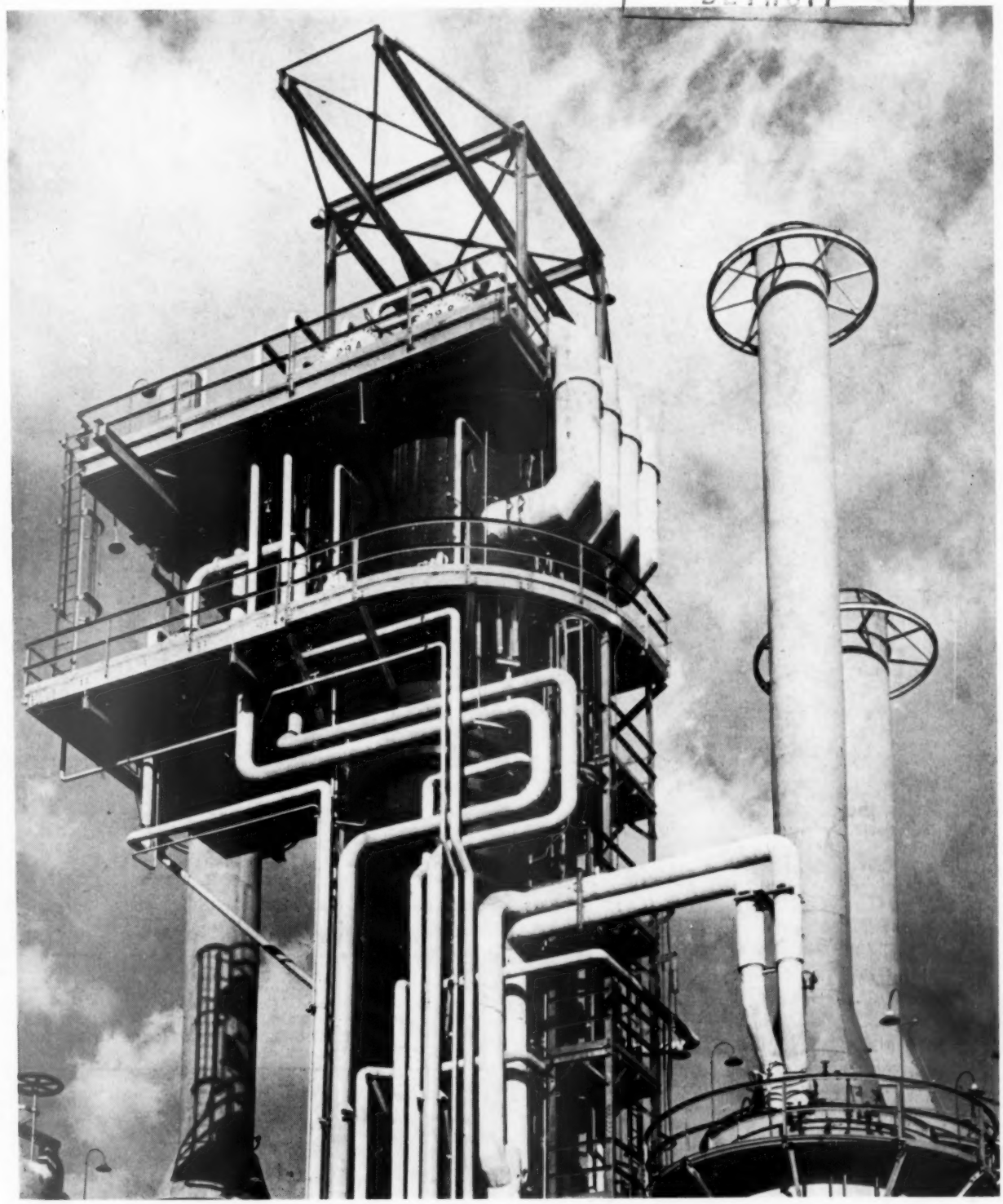
Section Two **January 3, 1945**



"HAIRPIN" EXPANSION U-BENDS, such as those illustrated above, are used exclusively by Sun Oil Co. because of their economy of space and material, efficiency of operation.

See "Critical Materials Saved by Expansion U-Bends"—page R-15

Bridle Wild Horsepower

and curb lowering reservoir pressures

MAINTENANCE of Pressure on Oil Reservoirs Thru Gas Injection Will Usually:

1. **Increase Total Oil Recovery**
2. **Minimize Lifting Costs**

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*GAS COMPRESSOR STATIONS • CYCLING PLANTS • GAS DEHYDRATION PLANTS • NATURAL GASOLINE PLANTS • FRACTIONATION UNITS • HYDROGEN SULPHIDE REMOVAL PLANTS • MECHANICAL AND NATURAL DRAFT COOLING TOWERS

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ENGINEERING CORPORATION

Engineers and Constructors

FAIRVIEW STATION HOUSTON, TEXAS

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"Industrial Research Should Be the Keystone in Our Post-war Preparedness Program"

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V. B. Guthrie, Editor, Technical Section • D. P. Thornton, Jr., Assistant Editor

PRE-VUE

Of February Features

Gasoline from Natural Gas By Fischer-Tropsch Process

New developments in the Fischer-Tropsch process increase the interest of refiners in this synthesis as one form of insurance to supplement petroleum for future supplies of motor fuel and other products. These developments include:

Direct production of iso-paraffin compounds by a new type of synthesis, leading to gasoline fractions of high octane value.

Use of suitable types of "complex action" catalysts to direct the operation toward the production of hydrocarbons of the desired size and structure.

Two authorities now engaged in extensive research in this field discuss these and other developments in an exclusive article in NPN's February Technical Section.

2600-Bbl. "Cat Cracker" Proves Itself in First Run

Fundamental improvements in the Fluid Catalyst Cracking process, as well as changes in design required for a small capacity unit, are said to have been proved through the first runs of the 2600-b/d plant at the aviation gasoline refinery of the Frontier Refining Co. at Cheyenne, Wyo. These design innovations are described and illustrated and some of the operating features briefly reviewed by an official of the company.

Progress in the LPG Industry

The liquefied petroleum gas industry continues to serve the domestic and industrial markets of former peace years. In addition, it is supplying an expanding demand from the chemical manufacturing and other essential war industries. A review of the developments in 1944 in this branch of the petroleum industry, by one of the leading authorities in this field, describes the growth in the use of butane and propane for LPG purposes.

Catalytically Cracked Gas Oils Tested for Burner Fuels

The advent of catalytic cracking has disturbed the former balance in refinery operations and created concern over supplies of conventional gas oils for pot-type burners. Investigations were undertaken by two agencies to study the burning characteristics of available fuels —straight-run, cracked (thermal and catalytic) and blends—in order to suggest suitable types for use under present wartime conditions. A progress report on the investigations thus far is to be presented.

POST-WAR CARS waiting for the Green light

The machinery for making automobiles was stopped by the red light of war...but automotive progress actually was speeded up

STRANGE AS IT SEEMS, during the very years when no civilian passenger cars were being made, automotive progress rushed ahead.

How could this happen? The answer is surprisingly simple.

An automobile is fundamentally a machine for transforming gasoline into transportation. Thus if gasoline is improved — and automobile engines utilize this improvement—then automotive progress has been made.

This is exactly what has happened during the war years. In order to meet military requirements for high-octane gasoline, the petroleum industry has built up a tremendous high-octane capacity. With the end of the war, large quantities of high-octane components will be immediately available for general use in civilian gasoline.

When automotive engineers design passenger car engines to utilize this improved gasoline, they will thus create *basically* better automobiles. Such cars will be far better...in *performance* and *economy* as well as in appearance.

Along with the improvement in passenger cars, you may also expect parallel progress in commercial engines. The opportunities for substantial improvement in the performance and economy of trucks and buses are as great as those for passenger cars.

ETHYL CORPORATION
Chrysler Building, New York City

Manufacturer of Ethyl fluid, used by oil companies to improve the antiknock quality of aviation and motor gasoline.

Wartime progress by America's petroleum industry has paved the way for fundamental progress in post-war automobile engine design.

REFINERY MANAGEMENT *and* PETROLEUM CHEMICAL TECHNOLOGY

Jan. 3, 1945
Volume 37
Number 1

A MONTHLY TECHNICAL SECTION OF NATIONAL PETROLEUM NEWS *incorporating International Petroleum Technology*

New Methods Introduced in GR-S Processing

Continuous Polymerization on Commercial Scale Boosts Plant Capacity By Estimated 40%; Carbon Black Mixed with Liquid Latex Speeds Milling Time. Better Rubbers Being Produced, Companies Claim.

IN THE PAST three years the rubber industry of this country has been faced with the biggest problem of its entire existence. It has been asked and expected to accomplish with a substitute material that which it took over 40 years of development and research to achieve with natural rubber.

Today that industry is successfully meeting most of the essential demands made upon it. Synthetic rubber is being produced in quantity, and is being used in place of natural rubber in many applications.

What does the rubber industry itself think of the synthetic rubber program? What about the problems experienced in manufacturing and processing synthetic? What advances have been made in overcoming these difficulties? Is butadiene-from-petroleum as satisfactory as butadiene-from-alcohol? How is synthetic proving out in tires and other products? How much does synthetic rubber cost now—how much will it cost after the war? What is the future outlook for synthetic rubber?

With these questions in mind, the Technical Section of National Petroleum News assigned a member of its editorial staff to visit the rubber fabrication center of Akron (Ohio) and discuss the situation with leading men of the industry.

Since over 85% of our synthetic program is concerned with production of GR-S (Government Rubber-Styrene) by polymerization of butadiene and styrene, most of the information gathered was in connection with this one product. Specialty synthetics, such as Neoprene and Thiokol, have been on the market for a considerable period (Neoprene was originally introduced by E. I. duPont de Nemours, Inc., in 1931 as "Duprene"). Compared to GR-S they are "old-timers", and, particularly considering their advantages over natural rubber in special applications, there is little doubt but that they will continue to hold and expand their position in the postwar rubber field. They represent, however, only a minor portion of synthetic rubber production, and are not directly concerned in this discussion.

In general, the consensus among technical rubber men with whom the problems were discussed is that:

1—Increased know-how and constantly improving methods are rapidly closing the gap between synthetic and natural rubber.

2—Compounding and manufacturing of tires with synthetic is about 80-90% as efficient as with natural rubber.

3—There is no appreciable difference in the GR-S synthetic rubber being produced today with butadiene-from-petroleum compared with that produced with butadiene-from-alcohol.

4—Passenger car tires made with GR-S synthetic give service under today's driving conditions comparable to that expected from first line pre-war tires.

5—Truck and bus tires, with the higher speeds and heavier loads to which they are subjected, present the toughest problem in the use of synthetics.

6—The further wide-spread use of synthetic rubber seems assured, although to what extent it will replace natural rubber is entirely a matter of conjecture, depending upon future developments, both technical and economic.

Production Methods Improved

One of the most important technological advances made by the synthetic rubber industry during the past year has been the development of the continuous polymerization process, announced last September by Goodyear Tire and Rubber Co.

In the past, the polymerization of butadiene and styrene to produce GR-S has always been completed in a group of single reactors, batch by batch. Each reactor was handled as a separate unit. The raw materials were admitted, the reaction allowed to proceed as far as desired, and the liquid latex withdrawn at the end of the cycle.

In the new continuous process, however, the reactors are all hooked together in series. Carefully timed pumps admit the ingredients in a continuous stream into the first reactor in just the right proportions and at just the right rate. The reaction takes place as the mixture moves through the chain of reactors and GR-S latex pours forth from the last reactor in a continuous flow.

From that point on processing methods remain unchanged. The liquid latex is stripped of unreacted butadiene and styrene, and is then coagulated, the crumbs of rubber being dried, baled and packaged for shipment.

According to Dr. R. P. Dinsmore, Goodyear's vice president in charge of Research and Development, this new method of polymerizing speeds up the rate at which the GR-S rubber latex is produced by 40%. And since the polymerization step has been the limiting factor in total capacity of synthetic plants, this process offers a potential 40% increase in the nation's output.

As originally built, the nation's synthetic rubber plants had a rated capacity for the production of 735,000 long tons of GR-S rubber per year. Subsequent improvements made it possible to increase their actual production to 130% of their original "design capacity".

The new Goodyear process, if fully utilized, would add another 40%, it is claimed, thus bringing the plants up to 182% of their design capacity, or to a total production potential of 1,338,000 long tons.

Use of the continuous process on a commercial scale in an actual synthetic rubber plant began last summer in a government-owned plant operated by Goodyear at Houston, after a Goodyear pilot plant at Akron had been operating successfully on the plan for nearly 18 months. Plans are now under way to use the new process in other synthetic rubber plants.

The cost of converting an existing plant operating on the batch method to the continuous method is only about 1% of the original capital investment, according to Goodyear. Basically the same equipment is used, with the addition of automatic control instruments for temperature, pressure and flow regulation. It is interesting to note that fewer pipes, fittings and valves are needed than when each reactor is operated as an individual unit.

The continuous polymerization process speeds up the production of GR-S

latex for a number of obvious reasons. Under the batch type operation it took about an hour to fill a reactor and another hour to empty it.

In addition it was found impractical to operate the reactor completely full. The top 10% of each reactor had to be left empty of all liquids to allow for the expansion in volume which takes place as the reaction gets under way and temperatures increase, and to prevent excessive pressures from being built up. Consequently, each reactor was filled to only 90% of its capacity, and with the shrinkage which takes place during polymerization, the reactor was only about 81% full when the reaction was stopped and the latex discharged.

Still more time was lost because the extraneous gases which gathered above the liquid in the 90% filled tank slowed down the start of the polymerization process as much as an hour.

In the continuous polymerization process, on the other hand, no time is lost in filling or emptying the reactors, or in waiting for the polymerization process to get under way.

And because the chain of reactors are all connected and continuously discharging at one end, no expansion space needs to be provided in the individual reactors. When the volume in any one reactor increases because of a higher temperature, the excess material just moves on into the next reactor, and so on down the line. Hence all reactors are 100% full at all times.

Another advantage claimed for the continuous polymerization method is that because of the closer control which is possible, it produces a more uniform synthetic rubber with better working qualities.

Summing up the advantages of the new process, Dr. Dinsmore says:

"Continuous polymerization allows a more efficient and simple plant operation. The rate of production is increased and, what is more, can be accomplished with an actual decrease in manpower requirements. More efficient, automatic control of the process can be obtained, resulting in a more uniform rubber."

Production Problems with Synthetic

Biggest problem in the processing of GR-S has been its incapacity to be worked as easily as the natural material. Crude rubber possesses a very desirable property. As it is worked or milled in Banbury machines it becomes softer and easier to handle. GR-S, on the other hand, while initially softer than natural rubber, does not break down and becomes easier to work as it is milled.

It is this property of synthetic which has in part been responsible for the difficulties encountered in turning out finished rubber products. The research director of one rubber company states that present tire production with GR-S is only about 85-90% as efficient as it would be with natural rubber. Another authority in the field sets the figure a bit lower—80%. In any event it takes more time to make a tire from synthetic rubber.

To understand this "lack of workability" we must remember that what we today call synthetic rubber isn't a true synthetic—it is not identical in chemical structure with natural rubber. Rather, the molecular makeup of synthetic resembles that of a plastic more closely than that of rubber.

Natural rubber is made up of a great number of molecules joined end to end to form a long chain—a condition known as straight-line linkage. And natural rubber can be worked rather easily because of this characteristic linkage. It was, in fact, this very property which made it so difficult to produce serviceable rubber goods until Charles Goodyear discovered vulcanization. The process of vulcanization consists of tying the straight-line molecular chains of rubber together by introducing molecules of other compounds (sulfur, for example) which bond onto the sides of the chains and form cross linkages.

Crude rubber might be likened to a city which has only parallel roads, with no cross streets — straight-line linkage. Vulcanized rubber is the city of parallel roads with numerous cross streets added, tying the roads together—cross linkage. Cross linkage isn't limited to one plane but occurs in the third dimension as well, so that we have a chemically integrated mass.

Like the natural product, our synthetic rubber is also made up of straight-line molecular chains. But in addition it contains a number of "foreign" cross linkages formed in the polymerization reaction, probably by impurities present which bond onto the sides of the straight-line chains of butadiene and styrene molecules. The result is that the molecules of synthetic rubber, being more closely tied together, won't let themselves be pushed around as easily as the molecules of synthetic rubber. As a consequence, more time is required to thoroughly compound the rubber and mix in the added materials, and the capacity of the equipment is correspondingly reduced.

It is possible to produce GR-S which is softer and handles easier—which has a lower index of plasticity. One way this result can be accomplished is by affecting the molecular structure as it is formed in the polymerization reaction, through such controls as temperature and modifiers. But as the index of plasticity is made lower in this manner the abrasion resistance and other properties desirable in the finished product are also decreased.

It is believed that to some extent, the development of continuous polymerization should help eliminate this problem of making an easier-to-mill rubber without sacrificing any desirable physical properties. Closer control of the polymerization reaction is possible under the continuous process method, according to Dr. Dinsmore, resulting in a rubber of improved quality and uniformity which handles more satisfactorily.

Carbon Black Mixed With Latex

Even more important, though, is another development—the incorporation of carbon black into the liquid latex before it is coagulated and dried. This development has been announced just recently by General Tire and Rubber Co.

A great deal of carbon black (40-50 parts per 100 parts of rubber) is used with rubber as a reinforcing agent, to improve the wearing qualities of the finished products. This was necessary with natural rubber and is even more essential with synthetics if the physical properties of the finished goods are to be adequate for hard usage.

In the past, this carbon (together with other compounding ingredients) has usually been mixed in with the coagulated and dried rubber on the Banbury or milling machines, which thoroughly masticated the mass to obtain even dispersion of all the materials. This is the point where a great deal of the extra time has been needed in the processing

Cost of GR-S

It is too early to say what the cost of synthetic rubber will be after the war, but there are many estimates being made.

Waldo L. Semon, director of Pioneering Research for the B. F. Goodrich Co., recently told the National Industrial Chemical Conference that:

"The average cost for synthetic rubber to date has been about 34c per pound, due to the necessity for making a large portion of the butadiene from high cost alcohol. Nevertheless, in the most efficient plants GR-S can now be produced from petroleum for an *out-of-pocket* cost of 12.2c per pound, and there are indications that on a peacetime basis this cost could be reduced to 10.7c per pound."

Dr. Dinsmore of Goodyear last spring claimed that "GR-S synthetic probably costs between 40 and 50c a pound at present. This is chiefly because of high-cost alcohol used in making butadiene and because of initial operating inefficiencies. It is estimated that butadiene and styrene can each be produced at about 8c a pound by efficient methods. With plant values adjusted to postwar replacement costs, rubber could be produced for 15½c."

Crude rubber prices in the past four decades have varied from 3c to $3 a pound. During the last five years before the war the average price for No. 1 Ribbed Smoked Sheets on the New York market was 18.83c a pound.

One thing at least is clear. Under present production methods, petroleum butadiene offers the only chance for synthetic to compete with natural rubber on an economic basis.

of synthetic rubber, because of its lack of easy workability.

To offset this increase in processing time, which would otherwise mean a corresponding decrease in finished goods that could be produced, additional milling equipment has been installed in most plants. Even this extra equipment hasn't completely solved the problem, though; skilled operators, especially difficult to find at this time, are needed to keep the machines moving.

As another solution to the problem, it was suggested that the carbon black be mixed in with the GR-S while it was still in the latex form, thus decreasing the amount of milling necessary. The idea wasn't particularly new; it had been tried before, both in this and other countries, with natural as well as synthetic latex, but no practical commercial method was in use. Pigmenting materials and compounding ingredients had been added to natural rubber latex in the past to produce pigmented products by deposition.

Before synthetic rubber came into the picture, there was little incentive to work out ways of mixing carbon black with the natural rubber latex as a reinforcing agent. In the first place, natural rubber wasn't so hard to work with. In the second place, the latex was coagulated at the rubber plantation, which would have meant shipping the carbon black thousands of miles or bringing the liquid latex over to this country and paying freight for transporting a high percentage of water.

The technical problems of successfully mixing the carbon black in with the synthetic latex were many. Direct addition of dry black did not ordinarily give a good dispersion, and usually caused partial premature coagulation of the latex. The use of a wetted black or of a slurry of black in water alone caused trouble with agglomeration of the black in the rubber, which was difficult to disperse.

As finally worked out by General's research department, a good dispersion of carbon black which blended readily with latex was finally obtained by mixing carbon black, water and a dispersing agent together. This carbon black slurry is mixed separately and then added in proper proportion to the liquid synthetic latex. The dispersing agents commonly used are divided into three classes: (1) condensation products of naphthalene sulfonic acid and formaldehyde; (2) lignin sulfonic acids or salts; and (3) glucoside extracts, quebracho extracts, tannin extracts, etc.

The method of coagulation of the dispersed carbon black-latex mixture differs somewhat from that commonly used in standard GR-S production. Experiments showed that coagulation was best accomplished by the use of a rapid, one-step process ("shock" coagulation), which apparently tends to entrap all the black in the coagulated rubber and produce a relatively clear mother liquor.

Using salt and acid for coagulation it was found desirable to use higher concentrations of both than are normal in present plant practice, and to use them concurrently. This was preferable in order to get the black and rubber to "set" as instantaneously as possible. A small amount of alum in conjunction with acid and salt materially reduced the required quantities of those two agents. It was also learned that the most effective way of controlling crumb size and eliminating fines was to avoid excessive agitation during coagulation.

The carbon black-rubber crumb obtained from the coagulation step is dewatered, dried and baled in the conventional equipment. As reported by General:

"The drying rate of the pigmented crumb is faster than normal because of its porous structure. In continuous plant operation it should be possible to effect a substantial reduction in the drying cycle. Furthermore, the crumb doesn't tend to stick or gum-up the dryer apron. Thus, delays in plant production due to shutdowns for cleaning the dryers should be eliminated.

"Although the resulting pigmented rubber crumbs can readily be baled and packed in the conventional manner, it is probable that some savings in packaging costs will be made possible by the firmness of the bale of black rubber. A standard size bale of black rubber weighs about 90 lbs., rather than the 75 lbs. which is the conventional weight of a bale of GR-S."

This latter statement regarding packaging savings seems debatable, however, since the 90-lb. bale of black rubber includes from 40-50 parts of carbon black for 100 parts of rubber, which knocks the actual rubber content down to less than 65 lbs.

It appears that the outstanding advantage of this method developed by General for incorporating carbon black in the liquid latex is the reduction in time required in the milling. According to tests conducted by the company, this milling time is decreased about 35%, which correspondingly saves equipment and manpower. In addition, the tests showed that the total power required for mixing this black-rubber is at least 20% less than for tread stock mixed in the conventional way.

General also claims that including the carbon black with the latex increases some of the desirable properties of GR-S, latex-mixed samples tending to have lower modulus with higher tensiles and elongations. They report that on road tests where 6.00 x 16 passenger tires were run for approximately 17,000 miles at 60 mph the latex-mixed tires were rated slightly better in regard to tread wear and equal in crack resistance.

Just how general the method of mixing carbon black in with the latex will become is hard to say. One difficulty is the diversity of carbon blacks that are used in various compounding formulas. At the present time, as far as can be determined, only the 30,000-ton government plant operated by General at Baytown, Texas, has been converted—and that only in part.

Other compounding ingredients could probably be incorporated with the liquid latex in this same manner, and General is conducting researches along these lines at the present time.

Sulfur, the usual vulcanizing agent in both natural and synthetic rubber, has also been difficult to mix in with synthetic, especially to the point of obtaining an even dispersion. According to one authority in the industry, an uneven dispersion of the sulfur may be in part responsible for some of the failures which have been experienced with synthetic tires. If the sulfur content is below the allowable minimum in one spot, that spot may not be properly vulcanized—and consequently will be weak. On the other hand, if sulfur is concentrated in one area

Future of Synthetics

Whether synthetic or natural rubber will be the dominant material in use in the future depends upon a multitude of factors—cost, quality, availability, demand.

With increased efficiency and improvements in methods, GR-S might possibly cost from 12 to 16c a pound, including amortization of capital investment. Natural rubber has sold for less than this estimate, but the average 1933-42 price was 16.49c a pound.

We already know from previous experience what we can expect from natural rubber. Synthetic rubber at the present time isn't as good in all respects. But its quality will undoubtedly improve—perhaps to the point of overcoming the current disadvantages entirely.

On the availability side, the total expected capacity of our synthetic rubber plants of all types is about 1,075,000 long tons per year. Prewar natural rubber production was about 1,600,000 long tons per year, thus giving the world a potential postwar production capacity of 2,675,000 long tons. (This figure doesn't include some 200,000 tons of synthetic capacity in foreign countries.)

On the demand side, the highest world consumption of rubber was 1,104,000 tons in 1937, and this country's top consumption was 783,000 tons in 1941. The postwar demand will be greater, because of new uses which have been and are being developed, a growing backlog of our own unfilled requirements, and an increased demand from "low-consumption" countries. One estimate sets the world demand at 1,526,000 long tons for the first postwar year, rising to 1,900,000 tons in the third year.

(even, as has been reported, to the extent of being visible to the naked eye in the finished product) that spot likewise will be weak.

This problem of sulfur dispersion has been solved to some extent by preparing what is termed a "master batch." The sulfur content in a batch of GR-S intended for tire production may run from 1 to 3%. With this small quantity it is difficult to get it thoroughly mixed in with the rubber. In making up the master batch, however, equal quantities of sulfur and rubber are mixed together, and because of the proportions it is possible to get good dispersion. A quantity of this master batch, sufficient to give the required sulfur concentration, is then mixed in with the rubber as it is being compounded on the mills. In this manner a fairly even dispersion of sulfur can be obtained.

Another difficulty in the fabrication of tires from synthetic rubber lies in its inability to adhere to itself. In the construction of tires, the plies are built up by laying one rubber-impregnated piece of fabric upon another. Natural rubber possesses the property of cohesion—it tends to stick to itself, so that the plies of fabric "hold together" and retain the proper relationship when placed in the tire mold.

GR-S doesn't possess this property. The pieces of synthetic-impregnated fabric don't adhere to one another sufficiently. Just why they don't isn't definitely known, but it is possible that the answer lies in the difference in molecular structure between synthetic and natural rubber. In order to keep the plies together so that they can be properly placed in the mold it is necessary to use a quantity of rubber cement between them. This requires an additional operation plus greater care and skill on the part of the workman in building up the tire—and more time.

Still further time is lost in the curing molds. It is necessary to leave synthetic rubber tires cool in the molds for a longer period of time before they can be removed.

Petroleum vs. Alcohol for Butadiene

There has in the past been some question as to whether or not butadiene-from-petroleum would produce rubber of quality equal to that produced using butadiene-from-alcohol. Theoretically, butadiene from either source should be the same—and is, chemically.

But there is always the question of impurities present and what effect they will have on the reaction and final product. And since the varying source of butadiene would in all probability result in different impurities being present, it is quite conceivable that there might be an undesirable difference in the products produced.

None of the companies questioned on the matter, however, has noticed any appreciable difference or variation in the GR-S, whether the butadiene used came from petroleum stock or alcohol. Isolated cases can be picked out where co-polymer plants have run into production difficulties using butadiene from one source or another. But as know-how increased on both sides—butadiene production and polymerization—the problems were overcome.

Just what effect impurities present in butadiene have on the latex produced is a much-debated question. Polymerization of sufficiently impure butadiene does tend to yield a product of lower molecular weight, presumably because the formation of long molecule chains is interrupted by the impurity or impurities present. But the research director of one rubber company suggests that perhaps a small amount of impurities are necessary to produce synthetic of good quality.

According to Dr. Dinsmore, of Goodyear, impurities present in butadiene, if present in sufficient concentrations, may tend to slow up the co-polymerization reaction of the butadiene and styrene. The latex produced, though, is not affected as long as the reaction temperature is not increased in an attempt to speed it up.

Quality of Synthetic Tires

Exhaustive tests of synthetic tires have been and are being made. Although few specific results have been published, the tests have proven that, on the average, synthetic rubber tires for passenger cars are almost equal in over-all performance to first line pre-war tires made entirely of natural rubber.

The Army Ordnance Dept. has done considerable test work and, as reported to the annual SAE meeting last year, "has every confidence in synthetic tires . . . . based on factual data from severe tests, plus the experience of hundreds of thousands of tires in service."

One authority in the rubber industry claims that "with proper care and under war-time driving regulations with their limited speeds, a passenger car tire made of 100% synthetic will give appreciably the same service as a 100% natural rubber (first line) pre-war tire." And a synthetic tire made with only 10% natural rubber will practically equal the performance of a first line pre-war tire under all conditions.

Comparisons made with 2nd and 3rd line pre-war passenger tires (which represented the bulk of sales) show today's synthetic tires to be even superior.

No one, including the Army and the rubber companies, claims that synthetic tires are equal to first-line natural rubber tires, especially in the truck tire line, because they definitely are not as good under all conditions. But the gap between the two is steadily decreasing, it is said.

Synthetic rubber has several disadvantages not found in natural rubber. It has low energy resilience, reduced elongation, and lower elasticity. Tires made of pure GR-S heat up when flexed at high speeds. Another difficulty is its low cut and tear resistance. Once a tiny cut appears, it grows rapidly ending the useful life of the tire.

These disadvantages aren't so important in passenger car tires. In the first place such tires usually are not subjected to heavy loads. And, at least at present, they don't get the abuse a heavy duty tire must stand. What heat is generated, is more easily dissipated because of the small size of the tire and comparatively thin walls.

But with truck and bus tires the situation is very different. Heavy loads and high speeds over long distances cause such tires made from synthetic to fail much more rapidly than natural rubber tires.

If 100% synthetic is used, the tires run hotter than those made with natural rubber. This high internal heat, which is the principal cause of tire failures, presents a great problem in the larger tire sizes because of their greater bulk and the adverse conditions under which they operate. The heat can't be dissipated through the thick walls rapidly enough, which weakens the tire and makes it more susceptible to abrasion and tearing.

One solution to the truck and bus tire problem is to use some natural rubber with the synthetic. This cuts down the heat generated, gives the tire more flexibility and elasticity, and lessens the chance of tire failure.

Another solution is the substitution of rayon or other synthetic fiber cords for the cotton usually used. The primary advantage of rayon over cotton lies in the fact that it becomes stronger as it dries out. Cotton fibers in tires possess a small amount of moisture. As the tire heats up this moisture is driven off, with the result that the cotton becomes weaker. Rayon fibers also contain moisture, but they get stronger, not weaker, as the moisture is lost. The result is an increase in the overall strength of the tire. With this increase in strength it is possible to use a thinner side wall and increase the rate of dissipation of heat.

Nylon fiber cords would probably be even more satisfactory. They not only possess higher strength than rayon, but would also lessen the "growth" of a tire in service. All tires become progressively larger in cross section (with correspondingly weaker walls) as they are used. This is true because the rayon or cotton cords, under the constant tension created by the internal air pressures, become stretched and don't return to their original shape.

Nylon, on the other hand, doesn't stretch or "bag" to as great an extent, one of the properties that makes it so desirable in stockings.

Before nylon can be used, however, certain technical problems must be overcome. Nylon is slicker than cotton or rayon, and, as pointed out previously, synthetic rubber isn't as sticky as the

(*Continued on p. R-75*)

New Solvent Lubricating Oil Plant Designed for Varying Blends of Crudes

RISING from the ashes of a fire that destroyed the old vacuum still at Champlin Refining Co.'s Enid, Okla., refinery is a new solvent lubricating oil plant, twice the capacity of the former conventional plant. The present facilities, which use the Duo-Sol solvent process, are rated at 1200 b/d capacity in terms of aviation and heavy-duty lubricants. Currently, this installation is running at capacity, producing 145-155 viscosity, zero pour test, 95 viscosity index bright stock for military use.

The fire at the old vacuum still two years ago toppled that structure to the ground in an almost unrecognizable mass of tangled steel. Although the major part of the auxiliary facilities for producing conventional acid-treated lubricants was not seriously damaged, the whole lube plant was put out of business when the vacuum still was ruined.

The management, after surveying the "mess", decided to take advantage of the opportunity to use as much of the old, undamaged equipment as possible in the erection of a modern lube refining plant. Thus most of the tankage, pumps, exchangers, condensers, centrifuges, etc. were used in building the Duo-Sol and other new units. Some of the old equipment was not useable, however, since it is not intended to go back to conventional lube manufacture. Still other equipment now in use for conventional refining of neutrals will be discarded as soon as war conditions permit.

Present operations at the new plant may be conveniently considered as consisting of three main processes: vacuum distillation of topped crude into wax distillate and bottoms (with, of course, production of gas-oil overhead); solvent extraction of naphthenics from reduced crude; dewaxing. (At present neutrals are acid—not solvent-treated.) As a final step, the oils are percolated through fullers earth for a polishing-up operation.

Vacuum Still Operation

The old vacuum still was the major casualty in the fire. Practically nothing was salvageable except a few of the condensers, the stripping still, most all of the tankage and a few pumps. The new vacuum still is a 20-tray tower, in which a 25 in. vacuum is maintained at the tower top. All of the exchangers and furnaces now used with it are new.

In operation, the tower charges topped crude from the tube-stills at approximately 720° F. Gas oil is taken overhead, at a temperature of approximately 400° F. It is sold as such or used in other processing operations such as cracking. A sidestream of wax distillate, at 500° F., furnishes stock for neutral oil.

A second sidestream of "slop" distillate leaving at a temperature of 650° F. is taken mainly to protect the reduced crude bottoms from too much light material and at the same time to avoid too much amorphous wax fraction in the wax distillate. Bottoms are reduced crude, leaving the tower at 665° F.

Wax distillate from the vacuum tower is first cooled, chilled to —5° F. and dewaxed by filtration through plate-and-frame filter presses. Dewaxed oil is cut to desired viscosity by fractionation, followed by acid treating and caustic neutralization. It receives a final "polish" by percolation through fullers-earth. The entire operation is conventional and unchanged from procedure prior to the fire.

Reduced crude, totaling 2850 b/d,

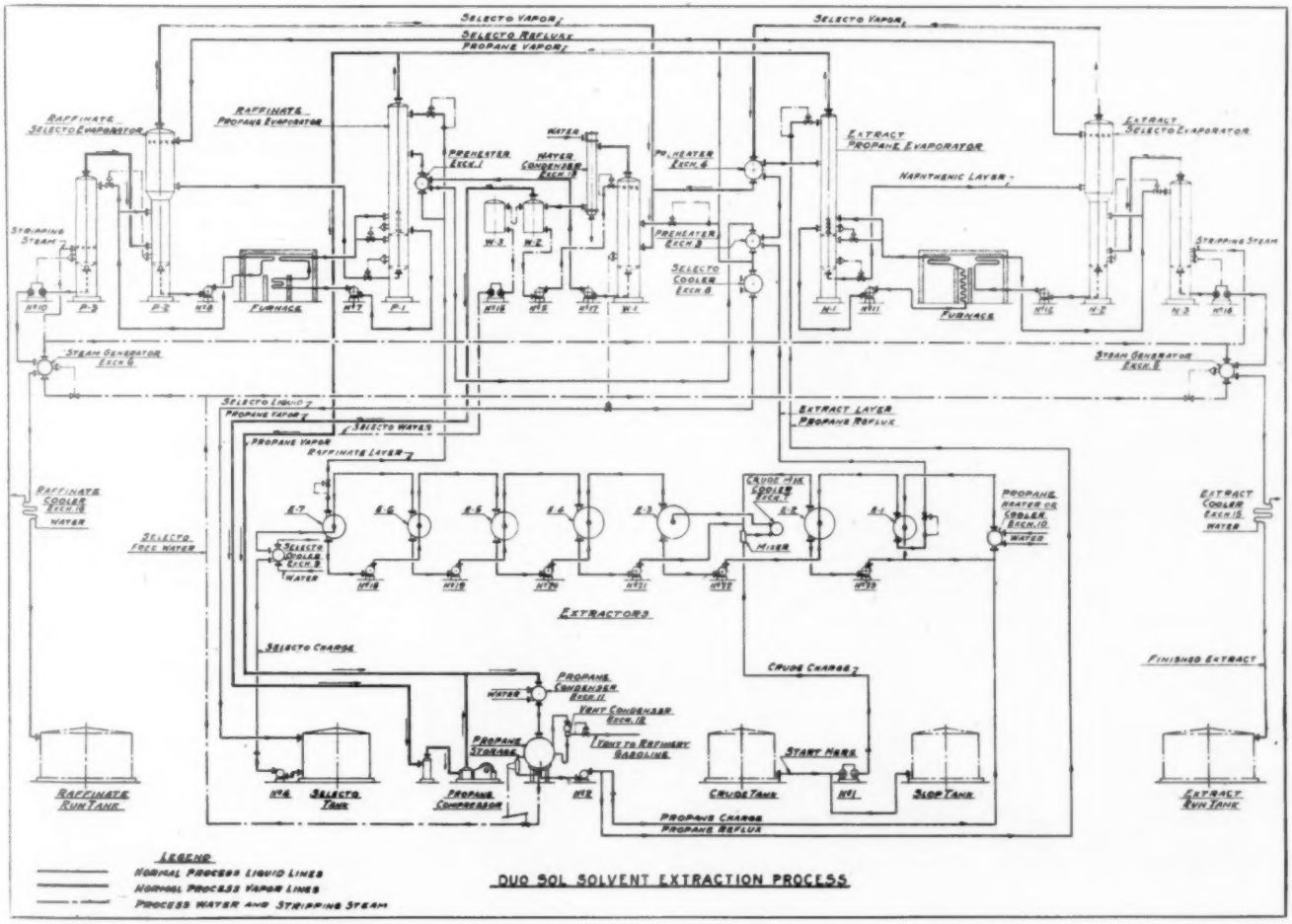


Fig. 1—Flow diagram of Duo-Sol solvent extraction unit in the Champlin refinery. (Courtesy Max B. Miller & Co., Inc.)

comprises the charge to the Duo-Sol unit, along with solvent ratio (based on crude charge) of 425% "Selecto solvent"—a blend of cresylic acid and phenol—and 350% ratio of propane—which serves as a diluent and also possesses deasphalting properties. A flow-diagram of the process is given in Fig. 1.

Duo-Sol Solvent Treating

As shown in Fig. 1, reduced crude at approximately 175° F. is charged from the crude tank into a mixer. Also entering the mixer is propane from No. 2 extractor and solvent from No. 3 extractor. After passing through the mixer, the mixture of crude, solvent and propane is cooled to 115° F. before entering the side of No. 3 extractor.

Temperature in Nos. 7 and 3 extractors is maintained at 115° F. No. 1 extractor is maintained at 120° F. No attempt is made to maintain a precise temperature at the other extractors. Pressure in the extractors is a nominal 300 psig; actually there is a small pressure drop over the battery due to frictional losses.

No attempt will be made here to discuss in detail the mechanics of solvent extraction.* Briefly, the ratio of cresylic acid to phenol in the Selecto solvent is adjusted to give the degree of extraction desired, based not only on the crude but also the desired end-product. The volume ratio of solvent to reduced crude also is a variable factor affecting the amount of extraction. Amount of propane used is not so critical, since its function is mainly as a diluent for the paraffinic oil.

*For a more detailed discussion see Kalichevsky, V. A., "Modern Methods of Refining Lubricating Oils," Chaps. X, XI, XIV, A.C.S. Monograph Series No. 76 (1936).

Flow in the 7 extractors is countercurrent, the raffinate layer emerging from the top of extractor No. 7 and the extract from the bottom of No.1 extractor, while solvent enters the system at No. 7 and propane at No. 1.

The recovery system shown in Fig. 1 in effect consists of two units, identical in equipment but differing in volumes of materials handled. One, the raffinate recovery system, removes solvent and propane from the raffinate; the other does the same for the extract oil. This is part of the system that had to be specifically designed for the broad type of crude (e. g. Mid-Continent) being processed and the product (e. g. bright stock or neutral, finished SAE grades, etc.) produced. The size of equipment installed in this instance might prove inadequate under the requirements for a markedly different type of crude, or in finishing a given product to widely differing specifications.

Raffinate phase as overhead from No. 7 extractor enters the recovery system in the top section of the raffinate propane evaporator tower. This is a high-pressure tower, operating in this case at 215 psig. A sidestream is taken off this tower and heated in a tube-still to 600° F., then reinjected at a slightly higher point than the takeoff for this sidestream. This reboiled material assures that tower bottoms are essentially propane-free, though they still contain the Selecto solvent.

Bottoms from the propane evaporator are charged midway in a second tower, the raffinate Selecto evaporator. Pressure in this tower is much lower, 5 psig. Overhead consists of vaporized Selecto, while the bottoms, now nearly free of the solvent, pass through a reboiler where they are heated to 650° F. before passing to the final stripping operation. Part of the reboiled material is returned to preheat the furnace feed with the balance to the stripper.

Stripping the raffinate of the last traces of Selecto is done by steam, which is generated by heat exchange and is maintained in a closed system to prevent loss of the small amount of Selecto dissolved in the condensate water. Overhead from the stripper is injected into the raffinate Selecto evaporator previously described.

Bottoms from the stripper, now essentially solvent-free, pass through a heat exchanger which serves to generate steam for the final stripping operation, thence to further cooling with water, finally passing to the raffinate run-down tank. The raffinate now is ready for dewaxing and percolation, which will be described in another part of this article.

Extract Recovery

Operations in the recovery of extract are quite similar to that for raffinate recovery. The major difference here is that relatively large quantities of Selecto are handled, whereas in the raffinate recovery system the major product rejected was propane with only small quantities of Selecto. For this reason, final purification of Selecto from the raffinate recovery system is combined with that from the extract system to minimize equipment cost.

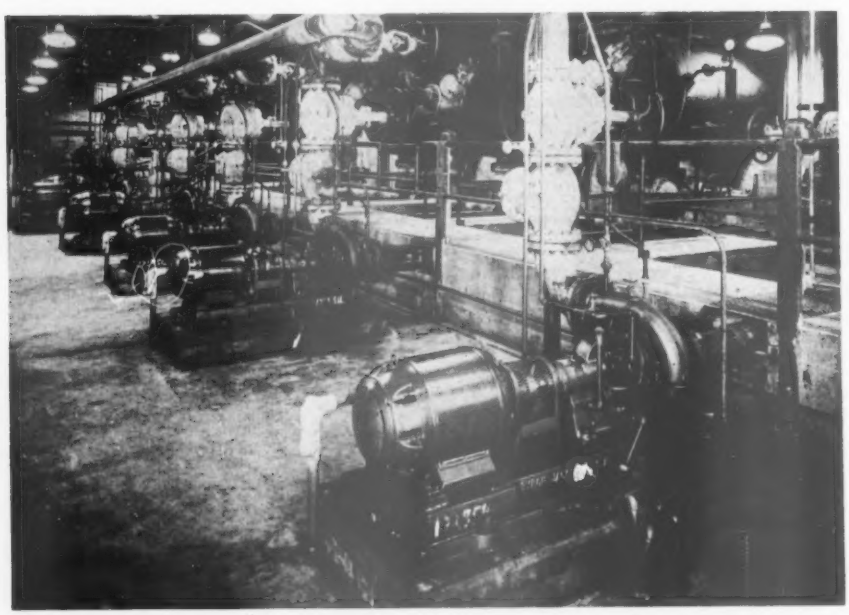
The extract layer from the bottom of No. 1 extractor passes through two preheat exchangers on its way to the extract propane evaporator, where it enters near the top of the tower (pressure is 215 psig.) Overhead from this tower consists of relatively small amounts of propane vapor, which pass to the same line that carries propane vapor from the raffinate purification system.

As before, a side-stream is taken off the propane recovery tower, heated to 600° F. and reinjected to assure that the naphthenate bottoms will be essentially propane-free. The naphthenic material then is charged to a low-pressure tower (5 psig.) where Selecto solvent goes overhead and the bottoms, after being heated to 650° F., are charged to the final stripper. Again, a small amount of this reboiled material is recycled to preheat the furnace feed.

The stripping operation is identical to that described for raffinate, with the same system for generating steam. Net result is that the finished extract is essentially Selecto free.

Selecto from the evaporators of both the raffinate and extract recovery systems is subjected to further treatment before being returned to storage for re-use. Vapor from the two evaporators is a mixture of solvent and steam, passing first to a dehydrator, designated in Fig. 1 as W-1, after serving to preheat extract coming from the extractor.

Selecto vapors enter the dehydrator



Extractor section of Duo-Sol lube plant. In foreground are the motor-driven centrifugal circulating pumps; one end of the extractors is visible in the background, showing level-gauges

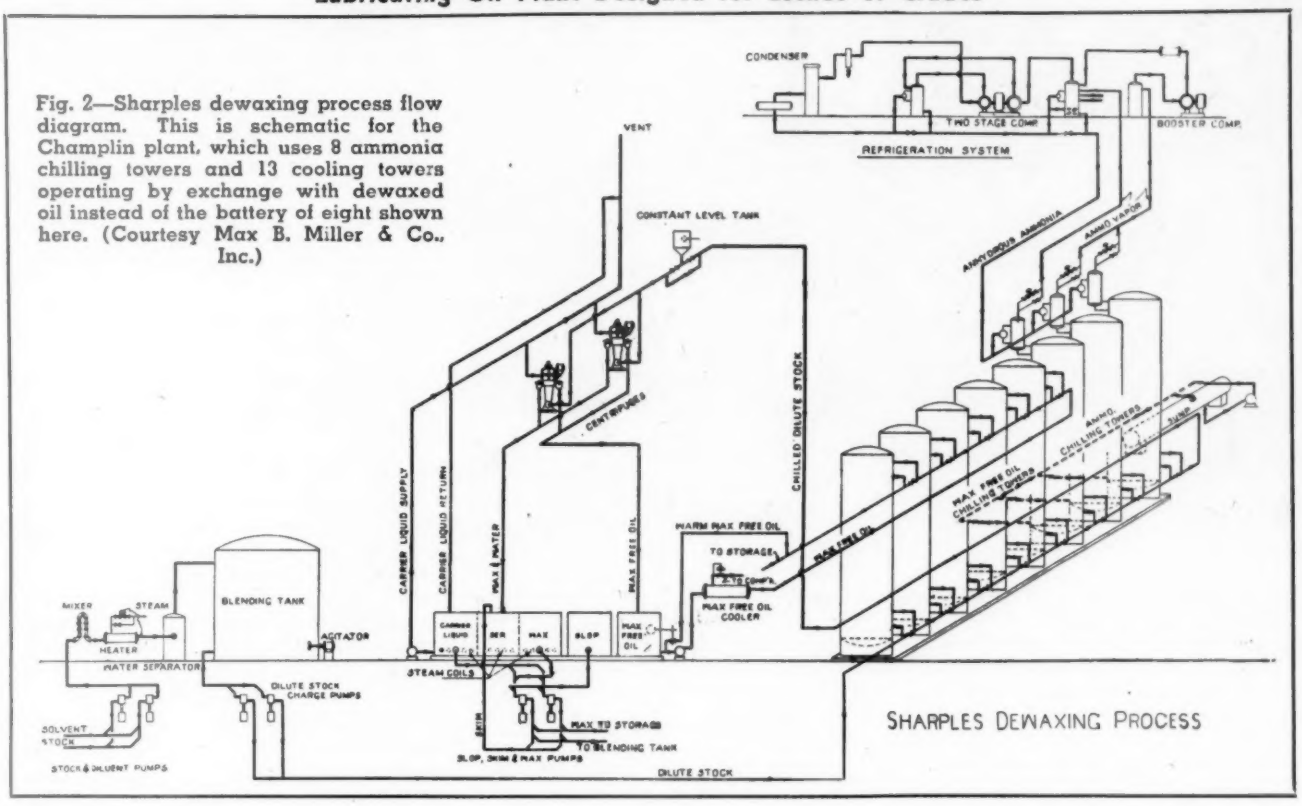


Fig. 2—Sharples dewaxing process flow diagram. This is schematic for the Champlin plant, which uses 8 ammonia chilling towers and 13 cooling towers operating by exchange with dewaxed oil instead of the battery of eight shown here. (Courtesy Max B. Miller & Co., Inc.)

(W-1) near the bottom. Selecto liquid condenses, passing from the bottom of the dehydrator via a pump to the preheater on the raffinate propane evaporator, thence to a series of coolers where its temperature is sufficiently reduced to permit pumping to Selecto storage. Vapor from the dehydrator consists essentially of an azeotropic mixture of steam and Selecto, passing overhead through a water-cooled condenser to decanters W-2 and W-3. The decanters are simple separators.

Bottoms from decanter W-2, consisting for the most part of water and a small amount of Selecto are reinjected at the top of the Selecto dehydrator, W-1. Overhead from W-2 is low-pressure propane, which is picked up by compressor-suction, compressed, cooled and charged to propane storage.

The liquid in the top half of W-2 is water, carrying a small quantity of Selecto solvent; it flows from W-3 to storage as such, where it is used in generating stripping steam used in raffinate and extract recovery systems.

Propane vapors from the high-pressure propane evaporators in both raffinate and extract recovery units flow directly to a condenser and storage, picking up on the way the compressed propane removed from the low-pressure stages of the recovery units.

Raffinate oil as produced by this Duo-Sol unit runs from 6 to 7 NPA color, constituting under present operations about 60% of the reduced crude charge. Extract oil, accounting for the other 40%, is either used at the plant as fuel or blended with other material to form a No. 6 railroad fuel. Extract oil viscosity is over 3000 SSU at 210° F. and has a specific gravity ranging from 1 to 1.03 (10 to 6° A.P.I.).

Comparisons of the topped crude charge to the vacuum still, reduced crude charge to Duo-Sol unit, and inspection of raffinate after solvent extraction are given in Table 1.

Of particular interest are color of 6+ N.P.A. after Duo-Sol treating and 7— N.P.A. after dewaxing, shown in Table 2. The small amount of color loss is due to handling and reheating. Also of interest is the low Conradson carbon residue indicated in Table 2, 0.4%, indicating that most of the asphaltic materials were removed by the solvent. Flash and fire are not unusual for a good Mid-Continent oil, but they do indicate that a good job of solvent and diluent removal was done. The high viscosity index, on the other hand, indicates the effect of naphthenate removal, while still securing 60% of charge as the most valuable product.

The dewaxing procedure used at Champlin's refinery is largely conventional and so will be treated briefly. The unusual feature is the use of heptane instead of a naphtha as diluent. The process used is the Sharples.

Duo-Sol raffinate is continuously blended in a tank with sufficient heptane to assure adequate fluidity at the lowest temperatures reached in the process (see flow-chart, Fig. 2). The diluted oil then is pumped to chilling towers.

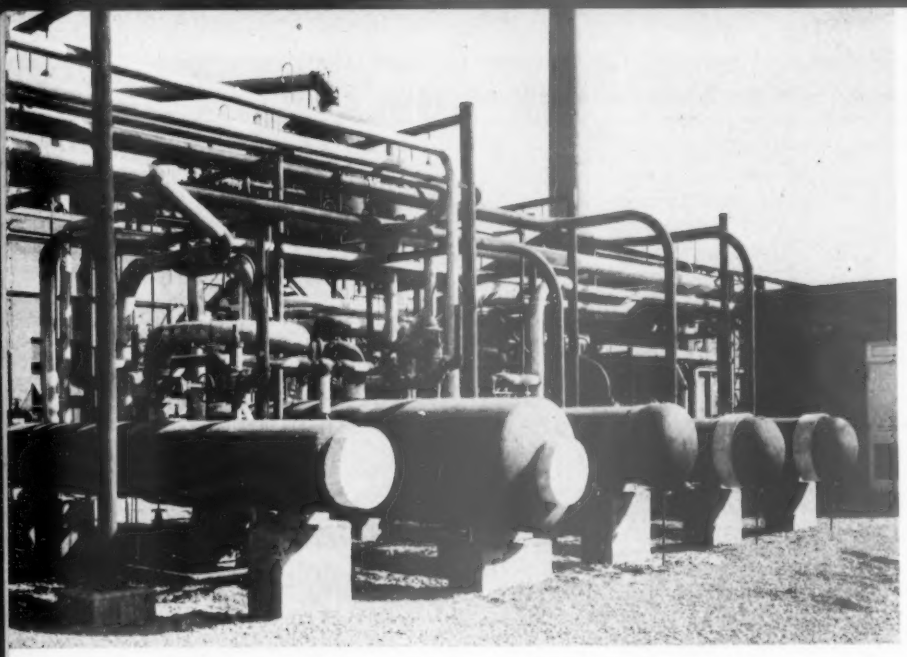
The first 13 chilling towers, each 10 ft. in diameter by 35 ft. high, cool incoming waxy oil by heat-exchange with dewaxed oil coming from the centrifuges. Following the 13 exchangers, the diluted waxy oil is gradually chilled to —45° F. by direct ammonia expansion in the 8 final towers. (The old plant used only 8 towers for the entire chilling operation, as shown in Fig. 2, but since lube capacity was approximately doubled, 13 more towers

TABLE 1—Physical Inspection Lube Charge Stock and Raffinate

Topped Crude to Vacuum Still	
Gravity, °A.P.I.	28.5
Flash open cup, °F	285
SSU Viscosity, 100°F	210
Reduced Crude to Duo-Sol Unit	
Gravity, °A.P.I.	20.5
Flash, C.O.C., °F.	580
Flash, Pensky-Martin, °F.	530
SSU Viscosity, 210°F.	326
Raffinate After Duo-Sol Extraction	
Gravity, °A.P.I.	28.4
Color, N.P.A.	6+
Flash, C.O.C., °F.	545
Flash, P-M., °F.	510
SSU Viscosity, 210°F.	130
Viscosity-Gravity Constant	0.7975
Volume—per cent of Charge Recovered as Raffinate	60
Solvent content (Selecto), % in Raffinate	0.03
Solvent content (Selecto), % in Extract	0.05
Ratio, Solvent to Charge, %	425
Ratio, Propane to Charge, %	350

TABLE 2—Physical Inspection of Dewaxed, Unfiltered Oil, Average

Gravity, °A.P.I.	27.7
Color, N.P.A.	7—
Flash, C.O.C., °F	550
Flash, P-M., °F	530
Fire, °F	630
SSU Viscosity, 210°F	145
SSU Viscosity, 100°F	2307
Conradson Carbon Residue, %	0.4
Pour Test, °F	0
Viscosity Index	96



External view of the new Duo-Sol plant, showing in the foreground some of the heat-exchangers and reboilers. Building at right houses some of the electrical facilities

were required for the most economical operation.) The chilled oil then is charged to a battery of centrifuges.

Two types of centrifuges are used: 16 of the so-called Super-Centrifuge type, with tubular bowl rotating at 16,000 rpm, and seven of Type D-4 (Sharples) which operate at 4800 rpm and remind one of the familiar cream separator. Both are motor driven and produce a petrolatum containing 25-30% oil, having a melting point of 150° F. and a light yellow color. The oil after centrifuging has a maximum pour test of 0° F.

Petrolatum is removed from the centrifuge bowls by a stream of hot water, passing to a separator tank where the two materials are separated by decantation. The hot wax, at a temperature ranging between 130 and 140° F., then is charged to a shell still, where the heptane is removed overhead in batch operation.

Dewaxed oil flows from the centrifuges into a surge tank, then back through the first 13 chilling towers where, by heat exchange, it is warmed by chilling incoming waxy oil. From this point it is charged to an "upshot" pipe still, not shown on the flow sheet, heated to 420° F., and then charged on trays 3, 5 and 7 of a 10-tray fractionator, 5 ft. in diameter by 63 ft. high.

Steam is added at the tower bottom, which has a liquid-level controller holding the oil level at 3.5 ft. Steam also can be added over the oil if desirable. Heptanes go overhead, with water vapor, to be condensed and separated in a conventional manner. Bottoms, which may contain a small amount of heptane and some solvent (about 0.03% Selecto), next are charged to one of a battery of 3 shell stills, where the temperature is maintained at 400° F. Still more steam is injected here to assure that the last traces of heptane and Selecto solvent are removed, as indicated by frequent Pensky-Martin flash tests as control. (The shell-still battery is so arranged that one still is filling, one emptying, and one is in operation.) Final step is percolation through a battery of percolators filled with fullers earth.

Champlin does not percolate the oil to meet specifications; the dewaxed oil already meets them. However, it is believed that percolation adds that "something" required for an absolutely finished oil (Table 3). Also, it is done as a safety precaution; any traces of solvents, unstable organic compounds or other materials which prior processing failed to "get" will be removed during the percolation.

TABLE 3—Inspection of Average Finished Bright Stock

Gravity, °A.P.I.	27.5
Color, N.P.A.	6½
Flash, C.O.C., °F	560
Flash, P-M., °F	530
Fire, °F	635
SSU Viscosity @ 210°F	145
Conradson Carbon Residue, %	0.35
Pour test, °F	0
Viscosity Index	96
Neutralization Number	Nil

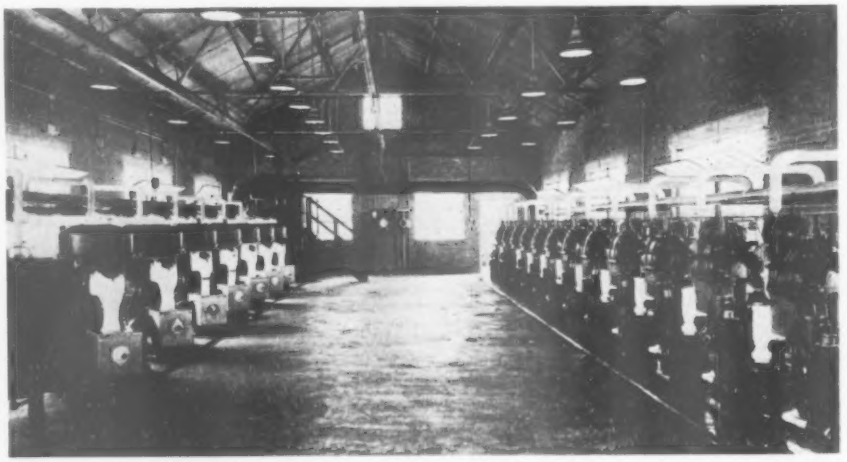
The oil produced by this process is odorless; there is no evidence of scorching or traces of solvent. Viewed by transmitted light there is "haze;" with reflected light the oil has an excellent "bloom".

Future Operations

As soon as materials conditions permit and backlog of government orders are filled, Champlin intends to discontinue all conventional refining of neutral oil, as it now has done with bright stocks. Instead of making neutral and bright separately, a long residuum will be taken off the vacuum still as bottoms and processed once-through to emerge as the desired grade of finished lubricant. It is expected that any SAE grade above 20 can be made in this manner without the necessity of blending to make finished material.

For the lower SAE grades, however, it will be necessary to split out some bright stock after the wide cut has been solvent treated and dewaxed. The excess bright stock then will be available for sale as such. Splitting will be accomplished in a second distillation, taking oils of SAE 10 and 20 overhead with oils of SAE 40 and above remaining as bottoms. All products, regardless, will receive a final "polish" by percolation through fullers earth—"not because we think the oil has to be percolated to meet specifications," to use the refinery superintendent's words, "but because we just think it makes a better motor oil than can be produced any other way."

Paraffin wax also will be marketed in greater quantity when the war ends. Current production of paraffin has been sharply curtailed because of the company's inability to secure sufficient personnel to operate the presses full-time.



Centrifuge room in the Duo-Sol plant. While this was not destroyed in the fire, new equipment has been added. On the left are the 7 new Sharples Type D-4 centrifuges added for new capacity; those on the right are the old Sharples "super-centrifuges" in use before the fire

SCIENCE IN NATURAL GAS*

New processes using natural gas as source material for chemicals, plastics and other products have been applied commercially in the wartime program and give promise of wider use in the future. These include the methane steam process, at present used in the manufacture of ammonia for explosives, which may be equally important in supplying raw materials for peacetime products. Combined with the Fischer-Tropsch process it is seen as a means for the production of high quality liquid fuels from natural gas. New types of commercial plants are also in course of construction which will produce oxy-hydrocarbon chemicals and acetylene, ethylene and other unsaturates from ethane-propane mixtures supplied by cycling and natural gasoline plants.

by James E. Pew** and Frank H. Dotterweich**

THE RISE of our petroleum technologists to meet the present war demands for aviation fuel, synthetic rubber and explosives and other war products has sent them into all scientific fields. No longer are they content with materials that will do the job well, but they constantly strive to improve the apparently perfect product, even duplicating in a period of minutes changes that Nature required millions of years to bring about.

Man, in his quest for liquid gold and once he had begun to get petroleum out of the earth, found that in many instances natural gas came ahead of it at terrific pressure. This was treated as a nuisance or hindrance, or at best as a thing of uncertain and local economic value. Although the value of natural gas as a fuel was always recognized, long before the advent of modern natural gas practices and even at the present time, enormous volumes have been blown to the air, burned and lost.

Today finds modern technologic procedures allowing for the development and perfection of means of discovery, production, transportation and storage of our natural gaseous hydrocarbons. The magic hand of science is also now converting this increasingly valuable natural resource into newer and super forms of energy and into varied chemical ingredients from which may be derived amazing products—products that will allow us to be victorious and to continue in our way of life with better health and greater happiness.

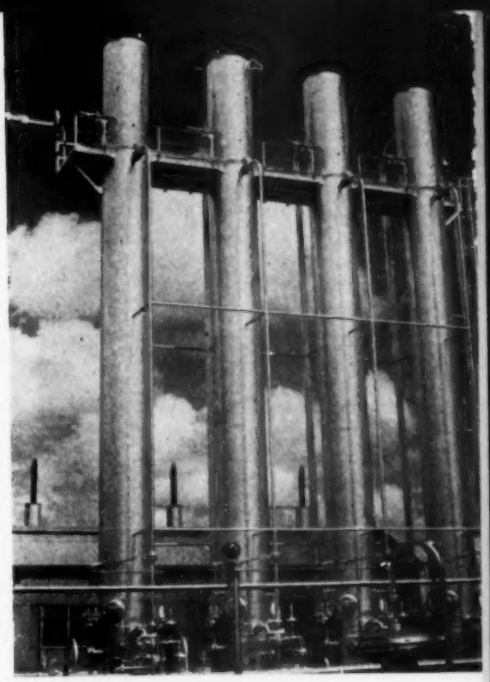
Thus, natural gas, once looked upon with scorn, now takes its place beside its twin, petroleum, in comparative value. In this paper, the authors will endeavor to direct major attention to science in natural gas; what has been accomplished during the present emergency, together with what may come about in the period to follow.

The scientist of the petroleum industry seems to be the Forgotten Man in the current public discussion on how long our petroleum reserves will be sufficient to meet the increasing demands for fuel and other useful products before we must turn to substitute sources. While such discussions are in progress, the petroleum technologist is writing his name in the scientific Hall of Fame by bringing about many advances in refining technique, chief of which is the production of enormous quantities of aviation fuel.

To power our long range bombers and fighter planes, super fuels high in octane value must be produced. These fuels must be capable of developing maximum power at full throttle to better enable heavily laden planes to take off and to climb and fight as conditions of war dictate. This property, termed "rich mixture rating," must be accompanied by a suitable "lean mixture rating" to enable the power unit to operate efficiently when cruising to and from the target or battle area. Thus, into one fuel is blended ingredients to insure power and efficiency, prerequisites in all phases of modern aerial warfare. To effect this, the liquid fuel to power our planes consists of a definite blend of base stock, iso-octane, alkylate, isopentane, tetraethyl lead, ethylene dibromide, together with additives of more recent perfection, like cumene, 2-3-dimethyl butane and others that cannot be reported due to restrictions.

It is true that the greater proportion of this fuel finds its origin in petroleum. However, it is equally true that the natural gasoline fluids produced from the natural gas, oil, and condensate fields of the nation contain a far greater proportion of the key or critical components than are found in an equivalent volume of crude oil. These accomplishments are only made possible by the scientist's ability to reduce, rearrange, and combine the molecules of petroleum and natural gas into definite geometric molecular patterns.

In ever striving to perfect newer and better aviation fuel, it appears that the gas chemists find their syntheses from concentrated light hydrocarbon fractions of ever increasing importance with unlimited possibilities. Thus, natural gas, although not the bulk raw material of our present and future aviation fuels, continues as one of the major sources for



High pressure absorber towers at Coastal Recycling Corp.'s Banquete (Texas) cycling plant operate at more than 1500 psig. Engine room forms the background

the production of super quality ingredients.

Rubber, quickly and in large quantities, was and still is a wartime "must." Every trick and process known to science has and is being tried to make more and better synthetic rubber. The amazing accomplishments in the development and production of our new synthetic rubber, however, cannot reflect truly the terrific pace the rubber chemist has set to bring this about. To produce butadiene, one of the most important ingredients of synthetic rubber, approximately 100 actual and theoretical methods exist for its synthesis, while a dozen or more known methods are being practically employed for its production.

Products extracted from natural gas are not the major raw material in the production of butadiene, being employed in only 13% of the present authorized rated plant capacity. However, in the production of other rubber "musts," like styrene and fillers such as carbon black, natural gas plays an important role, especially in the latter.

Today's synthetic rubbers, wherever they find their origin, in common with the liquid latex from natural rubber, are dependent for their toughness, and resistance to wear, in addition to their tensile strength, upon a submicroscopic derivative of natural gas—carbon black. Natural rubber and synthetic rubber have unusually low tensile strength in the pure state. To produce the desired strength and wearing properties, the scientist has developed carbon black to the point where the tensile strength of synthetic rubber is increased by 600%. Whereas natural rubber required one type of black, paint another and ink another, synthetic rubber requires yet another.

With the development of satisfactory

*Presented before the Texas Academy of Science, Galveston, Nov. 10, 1944.

**Director and Technical Consultant, respectively, Natural Gas and Natural Gasoline Division, Petroleum Administration for War, Washington.

carbon blacks for the compounding of synthetic rubber, a new problem, or bottle..eck, was encountered, that of compounding the black with the rubber. Thus, it the production of synthetic rubber was yesterday's problem, its processing is today's. Once again the scientist has made available new processes whereby carbon black slurry is added to the liquid rubber, permitting a finished rubber with perfect distribution—a natural blend rather than mechanical. This achievement, together with a reported new continuous polymerization process, has the possibility of the greater use of synthetic rubber even after natural rubber is available, because these new processes reduce the cost of synthetics in addition to producing a better product.

These developments are continuous, with one of the latest and most outstanding being that of including a carbon chain, thus producing electrically conductive rubber. Thus the dreaded ice formation upon airplane wings may be better eliminated by electrically heated rubber covering. Also, electrical conductive products may allow for the dissipation of electric charge heretofore suspected as the cause of unaccounted for accidents. Again it appears that predictions, frequently voiced in the past, to the effect that synthetic rubber products or synthetic natural rubber blends would produce superior products at a lower cost than those manufactured exclusively with natural rubber, each day draw closer to reality.

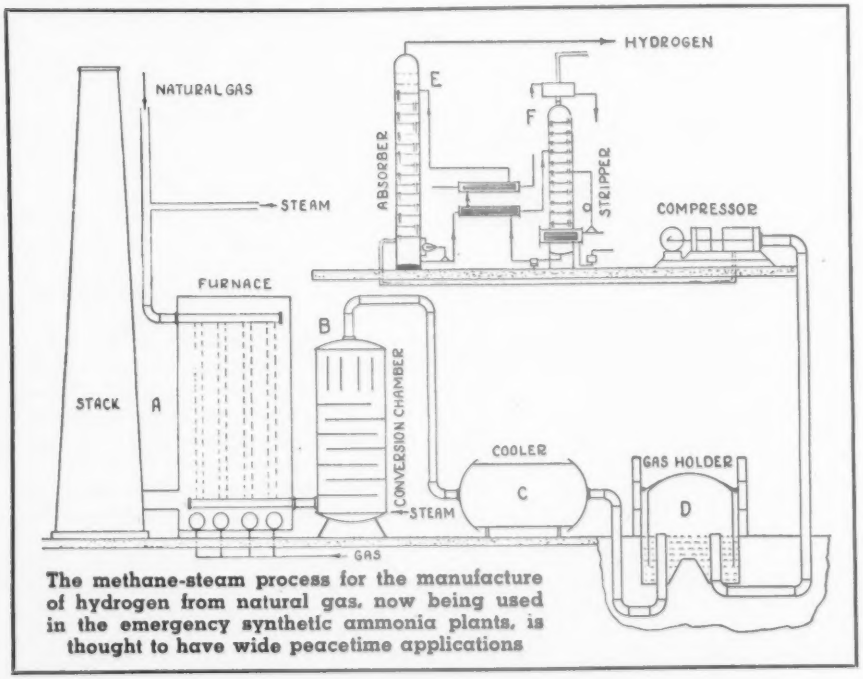
The use of natural gas as a raw material in highly efficient processes requiring a minimum of new critical construction materials has made possible the production of the immense quantities of explosives required for the war. The significance of ammonia in the production of explosives is well-known. Our modern block busters find formaldehyde, ammonia, together with nitric acid, indispensable for the production of one of its major ingredients—hexogen. The production of these materials from natural gas has thrust the latter to the fore in the present emergency.

Probing more closely into these accomplishments, it may be noted that this, to a great degree, has been made possible by the development of a process in which natural gas and steam react to produce hydrogen or a mixture of carbon monoxide and hydrogen with amazing overall yields.

This process by which natural gas and steam react to form carbon monoxide and hydrogen is equally important in supplying raw materials for the production of peacetime products as it is products of destruction. As will be shown herein this may be a major source of raw materials required for the production of plastics and synthetic fuels.

At the present time, there is much discussion relating to the use of the afore-mentioned process, together with the synthine (Fischer-Tropsch) process, the combination of which allows for the production of liquid fuels from natural gas. Naturally, the perfection of such a combination of processes to produce liquid hydrocarbon fractions on a favorable economic basis could result in an enormous quantity of natural gas being used, thereby depleting our natural gas reserves. This seems improbable, although the operation of pilot plants indicates a favorable economic conversion, with plans for at least one commercial plant underway.

It appears that the Synthine process using natural gas as a raw material may be used to produce select hydrocarbon fractions, performing a duty similar to that of our propane and butane fractions in the preparation of key components for aviation fuel—the bulk of our petroleum fractions continuing to come from our crude oil supply. One of these select hydrocarbon fractions increases the cetane number of diesel fuel and gives promise of remarkable improvements to the present fuel supply for many diesel-powered ships in the fleet.



The methane-steam process for the manufacture of hydrogen from natural gas, now being used in the emergency synthetic ammonia plants, is thought to have wide peacetime applications

Synthetic plastics are fast becoming wartime substitutes for critical materials, while some of them are among the critical materials themselves because of superior qualities for certain specialized uses. In his development of plastics, the scientist has opened new fields in which they exhibit unique properties. Some are like glass, others rubber, some resist corrosive chemicals of all types, still others exceed the resistance to vibration and fatigue failure that conventionally used metals exhibit.

In this paper it is impossible to discuss exhaustively the properties and uses of all plastics for they appear to exist in endless numbers. However, a few of the more outstanding, which proven processes may produce from natural gas as the major source material, will be set forth.

The gas chemist has used an invisible thread to produce the Acrylic resins presently marketed under the trade names of Lucite and Plexiglas. This nonshatterable plastic, approaching invisibility through transparency, assures maximum visibility and security to our pilots, bombardiers, and gunners. It is but one of the wartime wonders of the scientist. Additional properties like superior transmission of light over glass, the piping of so-called cold light, the ability to transmit the germ killing ultra violet light, should find it extensively used to insure brighter, healthier homes of tomorrow.

As the scientists' knowledge of the larger molecule progressed, it was soon evident that the preparation of purely synthetic fibers and filaments was possible. Thus, the perfection and production of Nylon, Vinyon and Saran followed each other in rapid succession.

The use of Nylon needs no comment. This superior form of fabric presently going directly into the war effort finds natural gas playing only an indirect role in its synthesis; however, Vinyon and Saran may be produced from the derivatives of natural gas under favorable economic conditions.

Vinyon, like Nylon, possesses high tensile strength, is odorless, tasteless, does not support combustion, and is permanently water-resistant and mildew-proof. Naturally, it too plays an important role in the war. Recently perfected processes suggest it will be made available in ever increasing amounts through the use of hydrocarbon gases as raw material.

Saran, another filament, is remarkably beautiful in appearance, strong, durable, tough, flexible, abrasive resistant and immune to soaps. Saran should find wide-

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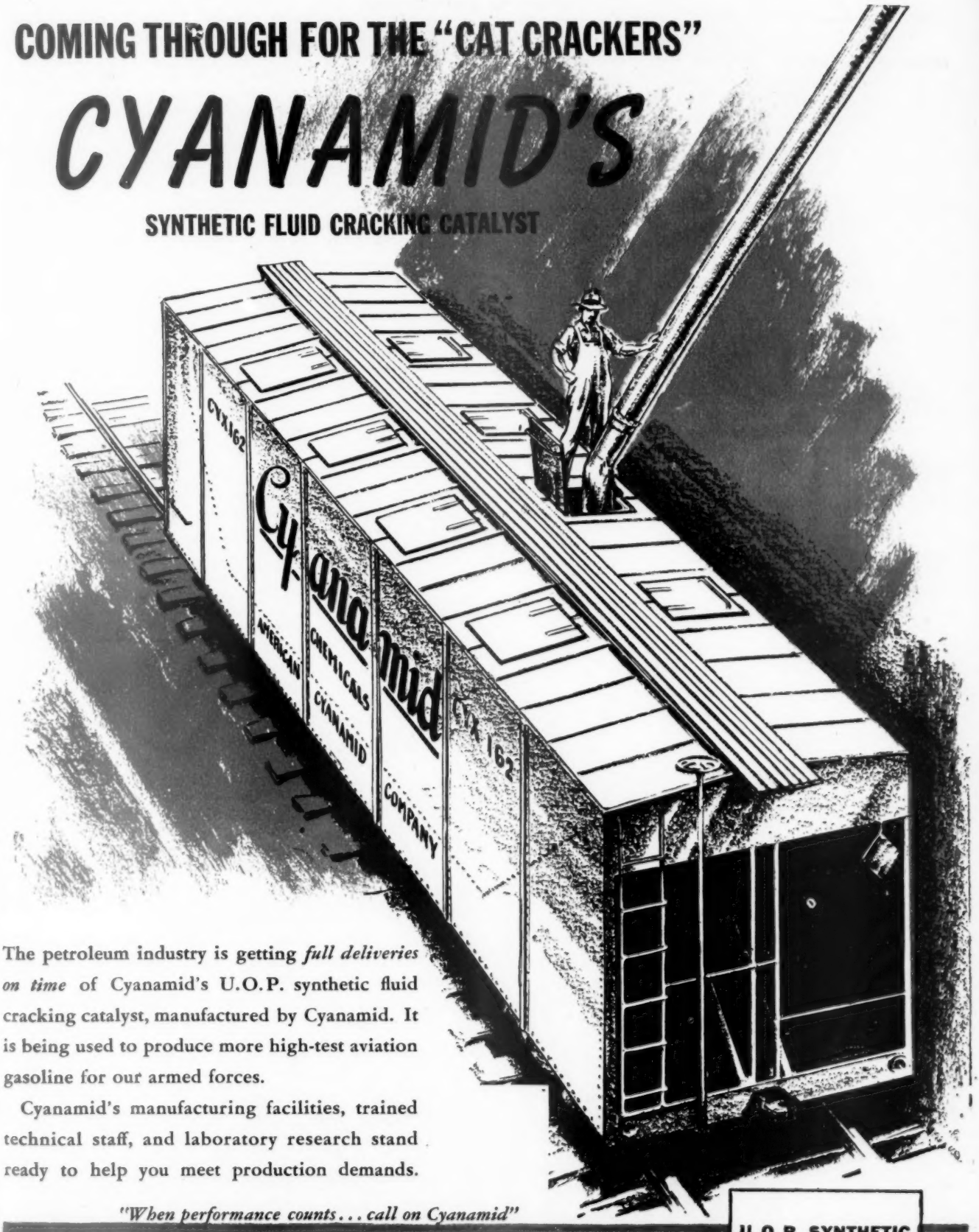

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spread use for many applications such as draperies and upholstering, in addition to its outstanding application in the form of non-corrosive non-heat conducting window screening.

As in the above, scientific progress insures the production of many valuable finishing agents, solvents, plasticizers, detergents and synthetic lubricants. Just to what extent natural gas will serve as a major raw material cannot be determined at present, but processes previously referred to suggest that it may be a source of raw material in the production of the important ethenoid and formaldehyde resins.

In order that scientific accomplishments may be beneficial to mankind, they must be of proven practical use—produced on a desirable economic basis. Thus, the contribution of natural gas in such proceedings resolves itself into a quantitative study. A greater portion of the dry natural gas, chiefly methane, presently being converted into chemicals; finds its major end product explosives. Thus the results of such a study are restricted. It has been pointed out that, although dry natural gas is of importance as a chemical raw material, especially in the production of hydrogen, water gas and ammonia, present trends suggest that the heavier fractions, like ethane, propane, and butane, are more desirable for chemical processing.

A recent study of the production and disposition of LP-Gas products by a Special LP-Gas Industry Sub-Committee included their use for the production of chemicals in the U. S. exclusive of the West Coast. This study* together with the estimated use on the West Coast indicates that a total of 389,127,500 gallons of propane, butanes, and butylenes, separately and as mixtures, were used as a chemical raw material in 1943. The 1944 requirement, with the latter nine months estimated, was set at 478,022,000 gallons, an increase of 23%. These requirements do not include butane for synthetic rubber and for isomerized isobutane for aviation fuel, these having increased 260% and 270% respectively for the same period.

*The data reported herein are taken from the preliminary report of a special LP-Gas Industry Committee and are subject to revision.

There is presently going on stream or is in the progress of construction a new type of commercial plant which will produce oxy-hydrocarbon chemicals and unsaturates like acetylene and ethylene. The former process, Catalytic Oxidation, employs preferably propane and butane as the raw material, with the latter process, Regenerative Cracking, using ethane-propane mixtures. These recently perfected processes insure the production, in large quantities, of many of the useful products previously mentioned under favorable economic conditions with the ingredients of natural gas being used almost exclusively as the raw material.

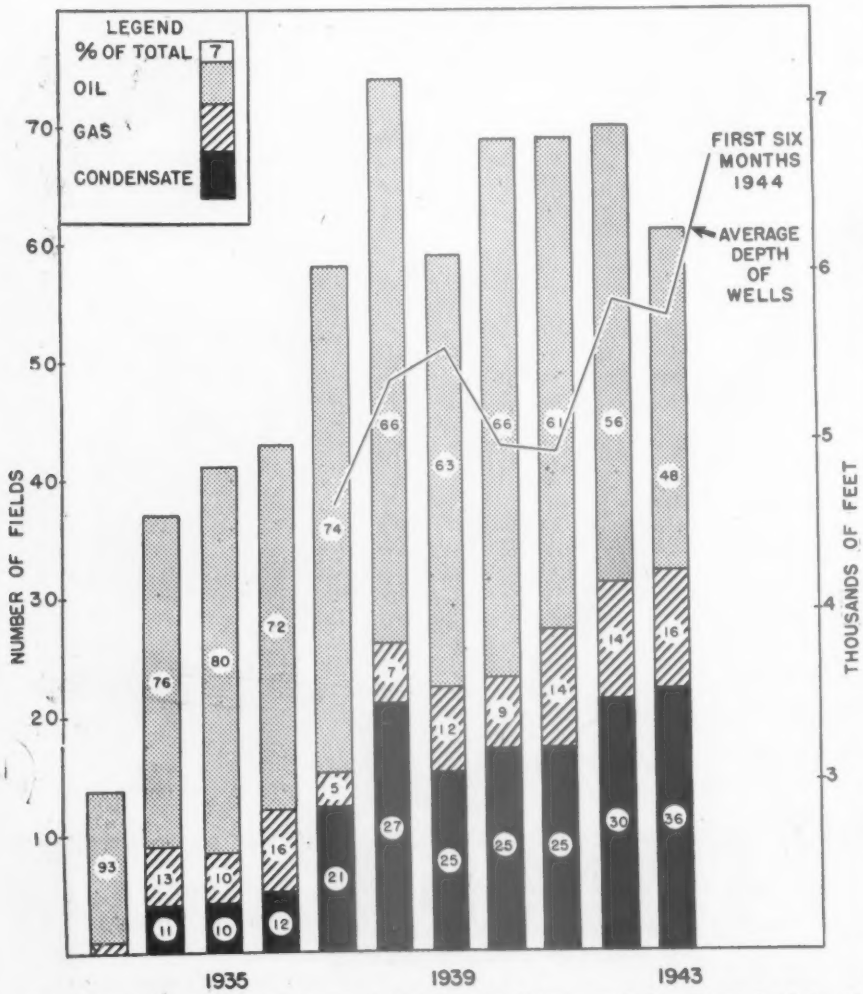
The search for crude oil has resulted in drilling to greater depths with increased discoveries of the so-called gas condensate reservoir. These deep production operations are made possible by a scientific-engineering combination insuring efficient geo-chemical and geo-physical exploratory methods, together with effective drilling and production procedures.

In the so-called gas condensate reservoir, Nature has failed to conform with the classic chemical laws and to cope with this unusual situation, it was necessary for scientific discovery to be practically applied over a relatively short period of time, so that the loss of underground valuable hydrocarbon fractions would be held to a minimum. It is significant to note that it was the engineers of the Texas Railroad Commission who were among the first to recognize this phenomena and who endeavored to control the production in such reservoirs to hold underground waste to a minimum. Representatives of this Commission now actively continue their constructive work in the field and it is interesting to note that more progressive state regulatory bodies are now cognizant of these problems and are taking steps to insure the underground conservation of our select hydrocarbon fractions.

The Petroleum and Natural Gas Division of the U. S. Bureau of Mines has turned virtually all its studies in the direction of supplying information needed by the PAW and by the petroleum industry in conducting the war program. Two of the least publicized tasks entrusted to this Division of the Bureau have been the study of condensate fields and their products and the program of supplying the large quantities of helium required in the total war effort.

The study on condensate fields and their products includes a complete analysis of the stabilized flow stream of both the gas and liquid under separator pressure and temperature, together with an estimate of reserves of condensate and probable recovery factors, supplemented with geological and engineering data. In securing all the essential data required to evaluate the productivity of condensate fields in accordance with the

(*Continued on p. R-79*)



New fields discovered in South Arkansas, Louisiana and the Coastal plain of Texas, showing the increase in importance of the condensate fields in recent years. (Chart prepared by the PAW Natural Gas and Natural Gasoline Division.)

Critical Materials Saved By Expansion U-Bends

EXPANSION U-Bends in refinery piping are economical of material and space, require less-skilled workers for fabrication, and do a better job, according to the engineering dept. of Sun Oil Co.

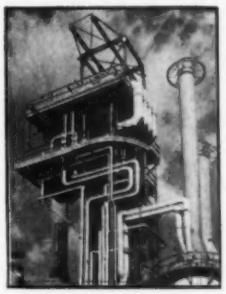
First investigated and adopted by Sun in the interests of economy, the expansion U-bend has been used exclusively in the company's refineries since 1935. For equivalent service, Sun engineers claim, the U-bend costs less than half as much as the more common lyre-type bend (also known as the double offset expansion U-bend).

Another advantage claimed by Sun for the U-bend is the manner in which it is constructed. The U-bend employs four weld-ells and three pieces of straight pipe, and can be made by the ordinary welder. On the other hand, the lyre-type bend requires a specialist, a first-class pipefitter, and the bending involves expensive shop work.

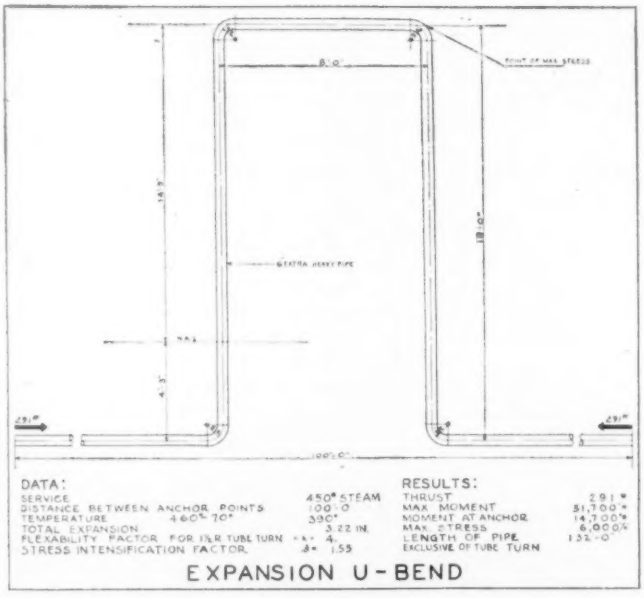
During the wartime construction period, Sun's devotion to the U-bend has resulted in additional savings of a particularly critical item—manpower. Because the ordinary welder is capable of fabricating the U-bend, the specialists who otherwise would have been tied up making lyre-type bends have been released for other essential work.

Explaining further their reasons for using the U-bend exclusively, Sun's engineering dept. states that "The U-bend provides flexibility in design to fit in with piping arrangements, and is more adaptable where space is restricted. The length and width of the bend can be increased or decreased in reverse ratio, within limits, to provide the same result depending upon whether space is limited horizontaly or perpendicularly.

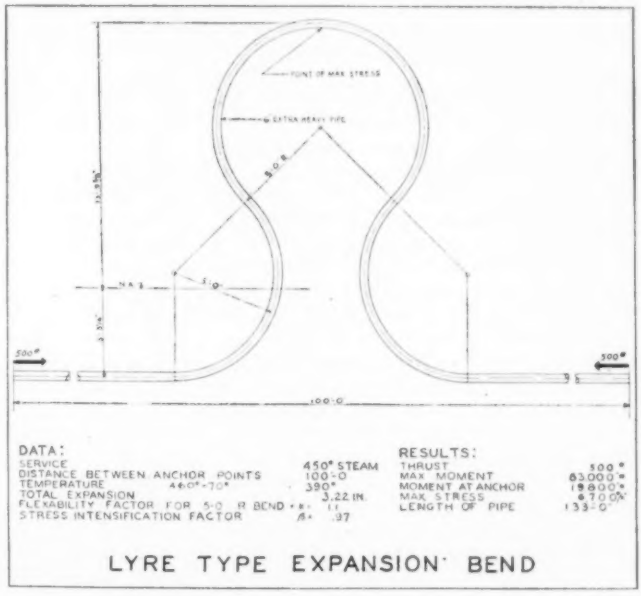
"Where thrust against equipment is a matter of concern, the U-bend is especially adaptable. Using approximately the same amount of pipe, and to provide an equal amount of expansion between two anchor points with equal stress on the expansion bends, the U-bend will do the job with about 40% less thrust on equipment. Moments (leverage or twist) at the anchor points will also be about 40% less. This is important where equipment sensitive to strain—such as pumps, turbines and blowers—are at the anchor points."



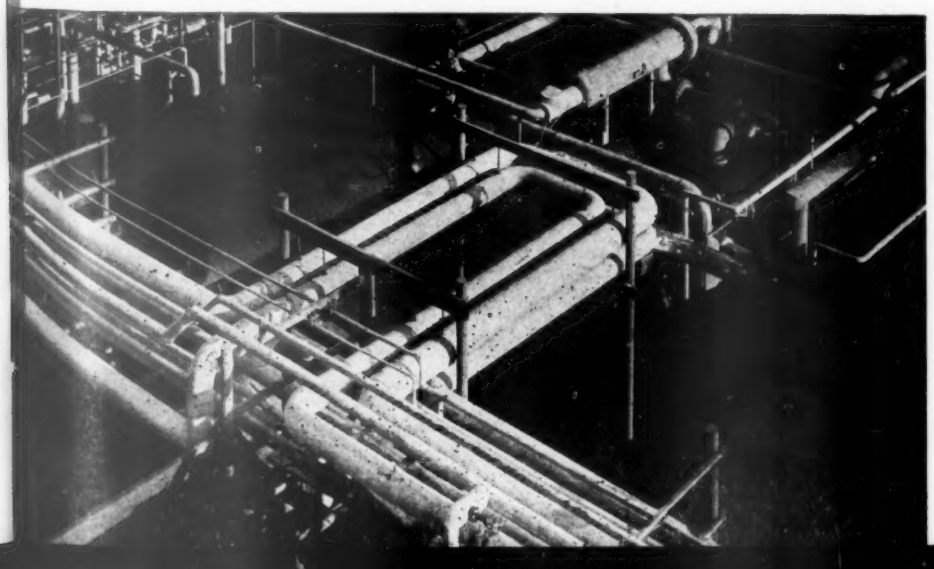
FRONT COVER: Closeup of Filtrol fractionating tower at the new $7,000,000 lubricating oil plant at Marcus Hook of the Sun Oil Co. The "hairpin" expansion U-bends under the lower platform are water outlet lines from overhead condensers. Above, at right, are the four oil vapor lines from tower to condensers. Lower right are twin feed lines from the furnace to the tower.



EXPANSION U-BEND



LYRE TYPE EXPANSION BEND



The two drawings above illustrate the comparison between a U-bend and lyre-type bend on a practical problem of providing a 100-ft. line to handle 450 pounds of steam at temperatures ranging from 460 to 470° F. Note that with the U-bend the thrust is less, the maximum moment is less, the moment at anchor is less, the maximum stress on the bend is approximately the same and the amount of pipe used approximately the same.

Left—The expansion U-bends in the foreground are for hot oil and steam lines at Sun Oil Co.'s new lubricating oil plant. (For full details on Sun's new lube plant see NPN's Technical Section, Nov. 1, 1944, pg. R-762.)

HEAT TRANSFER EQUIPMENT*

Principles and Constructional Details of Typical Tubular Units Are Reviewed To Aid in a Better Understanding of Maintenance and Repair of Exchangers

*By P. W. Blaylock***

Various types of multi-tubular heat transfer equipment used in the chemical and allied industries are described briefly. Details of the assembly and fabrication of this type of equipment are discussed and reference is made to various construction codes and rules which govern the mechanical design and proportion of the various elements. Some of the practical considerations governing the selection of tube diameter, tube length, baffle arrangement and general design for a given application are discussed and illustrated.

A number of recent papers have summarized contemporary developments in the theory of fluid flow and heat transfer in tubular heat exchangers.[5,10,14,23]

In spite of this adequate treatment of the theory there are few convenient references to the problems involved in the mechanical design and fabrication of this type of equipment and the limited information which is available is so widely scattered in technical papers, construction codes and manufacturers advertising matter that it is thought that a brief discussion of the constructional details of some typical units might be of general interest.

In recent years experimental studies and observations on plant scale equipment have led to a better understanding of the factors governing the transfer of heat between fluids and solid surfaces, and the importance of high fluid velocities has become clearly evident.

The basic consideration influencing the design of most modern heat exchangers is, therefore, the arrangement of tube passes and baffles in order to obtain the maximum possible fluid velocities with the available pressure drops.[2] Figs. 1-6 outline a number of the conventional types of exchangers. Although some radical departures along novel lines have recently been made with considerable success, it will be found that most industrial equipment is of this standard multi-tubular type and resembles one or other of the above illustrations in many of its details.

The vertical unit shown in Fig. 1 is widely used for condensing and subcooling pure vapors and in the dehumidification of mixtures of condensable vapors with permanent gases. The downward flow of vapor and condensate inside long small diameter tubes is found to give efficient liquid cooling and often observed coefficients are well above those calculated by the various modifications of the Nusselt formula.[22] The segmental shell side baffles may be proportioned and spaced to give high velocity flow of even small quantities of the cooling liquid and the tube bundle may be withdrawn from the shell for cleaning and repairs.

The horizontal unit shown in Fig. 2 is suitable for installation where head room is limited and is much used for condensing pure vapors, especially in vacuum service where the small pressure drop of the vapor in the shell is an appreciable advantage. In practice it is found that this design has poor condensate cooling characteristics and as there is no positive flow of vapor non-condensable gases tend to accumulate in stagnant regions in the shell. This type of unit is therefore not recommended where there is a heavy liquid cooling load or where large quantities of non-condensable gases are present in the vapors. However, by a suitable arrangement of channels in the heads a high velocity flow of cooling liquid may be maintained inside the tubes, and silt and slime-laden waters that would quickly foul a shell side baffle arrangement may be used without difficulty.

The outside-packed, floating-head, baffled shell exchanger shown in Fig. 3 is often used for general purposes involving no change in state. By a judicious arrangement of baffles and tube passes high velocity fluid flow may be maintained in both the shell and tubes. Unfortunately, however, the fluid flow is not truly countercurrent and very often where close temperature approach is required only a small fraction of the available temperature difference is effective.

The multi-unit long-tube design shown in Fig. 4 gives true countercurrent flow with high fluid velocity, and although its initial cost is high its simplicity and effectiveness make it ideally suited for chemical work involving valuable or corrosive fluids.

The vaporization of liquids may be effected in any one of a number of different types of exchanger but the units illustrated in Fig. 5 and Fig. 6 have become familiar through general usage—in the first of these the heating medium is passed through the tubes and causes the heated fluid to circulate by natural convection around the outside surface of the removable tube bundle. The velocity of the heated fluid in the shell is small and this design is most suited for use with clean, low viscosity fluids with high boiling heat transfer coefficients. In the vertical type the heated fluid flows upwards through the tubes by either natural or forced convection while the heating medium passes through the shell. In forced circulation, high velocities up to 15 ft./sec. are commonly used in the tubes, and viscous and dirty fluids can be heated with efficient heat transfer and a minimum of surface fouling.

Although each of these designs differs in principle from the others it will be seen that the component parts and method of assembly are similar.

A better understanding of the factors involved in the fabrication of this type of equipment may be had from an examination of Fig. 7 which illustrates the parts of a typical floating head type of vertical vapor condenser (Fig. 1). In assembling, the tube sheets are first clamped at the correct spacing in an assembly jig and the baffle support rods are screwed into the threaded holes tapped part way into the fixed tube sheet. Baffle spacer pieces and baffles are then slipped alternately onto the support rods and finally locked into place by nuts at the end of each rod. The tubes are then passed through the holes drilled in the tube sheets and baffle plates and when the tube bundle is complete the ends of the tubes are secured in the tube sheets by mechanical expanding with a suitable tool. The tube bundle is then slipped into the shell, and the top tube sheet to shell joint is made. After the packing has been placed in the expansion joint, water pressure is applied in the shell in order to test the tightness of the tube expanding. The heads are then bolted into place and when the gasketed head

Nomenclature For Figs. 1-6

1—Shell.
2—Fixed head.
3—Floating head.
4—Transverse baffles.
5—Longitudinal baffles.
6—Baffle spacers.
7—Baffle support rods.
8—Fixed tube sheet.
9—Floating tube sheet.
10—Expansion joint.
11—Tubes.
12—Tube support rods.

*Presented before the American Institute of Chemical Engineers, Cleveland, May 15, 1944.

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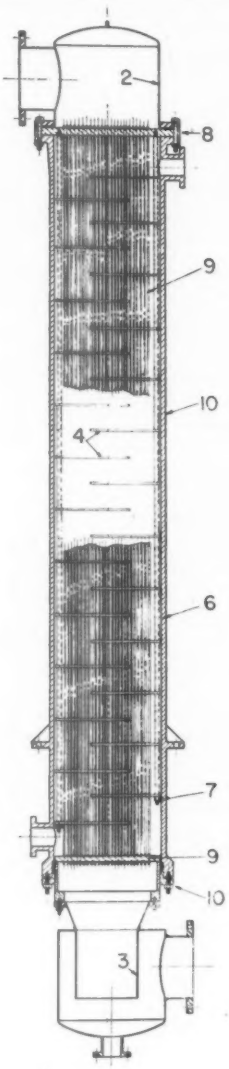


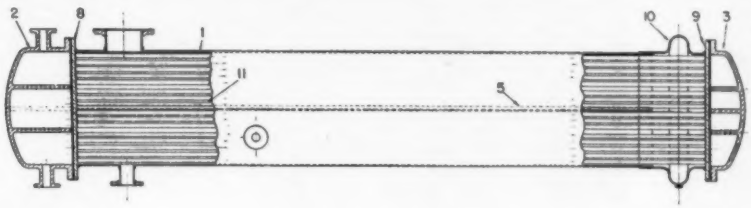
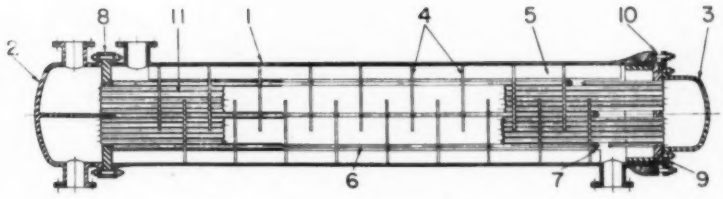


Fig. 1 (Left)—Verticle Vapor Condenser and Gas Cooler

Fig. 2 (Above)—Horizontal Vapor Condenser—Two-Pass Shell—Multipass Tubes

Fig. 3 (Below)—Outside Packed Floating Head Exchange—Two-Pass Tubes—Baffled Shell



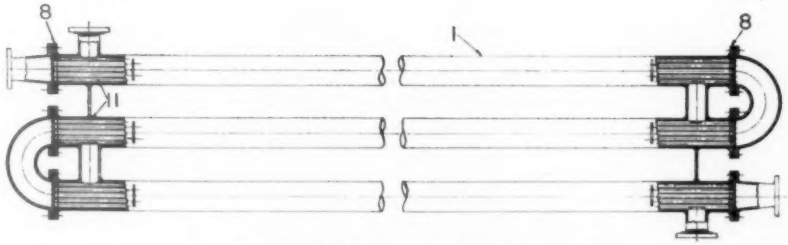
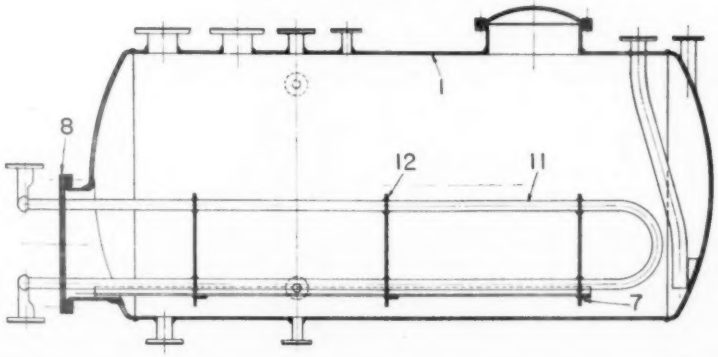
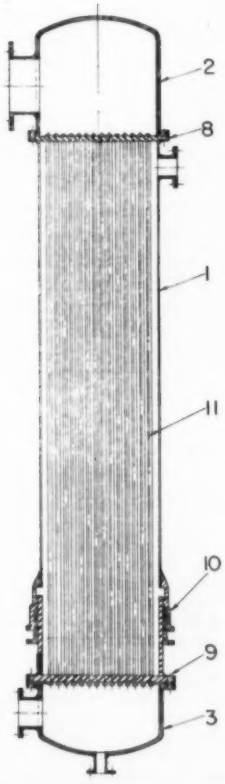


Fig. 4 (Above)—Multi-Unit Long Tube Heat Exchanger

Fig. 5 (Below)—Kettle Type Liquid Reboiler

Fig. 6 (Right)—Verticle Liquid Reboiler





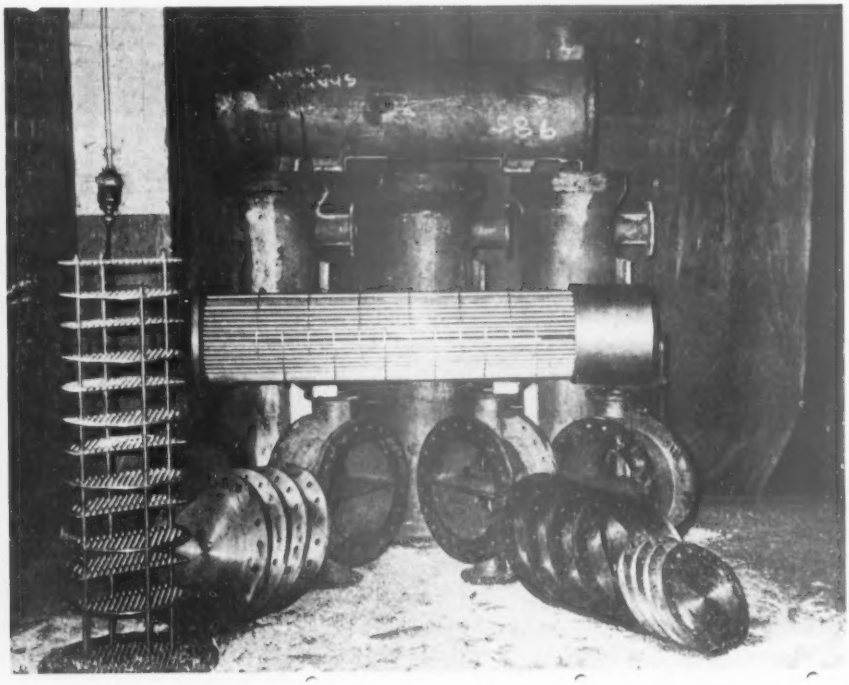


Fig. 7—Shop assembly of a typical floating head vertical vapor condenser

joints have been tested the unit is ready for service.

Although the construction described is essentially simple it will be seen that there are a number of gasketed and expanded joints and some closely-fitting assemblies. In practice each of these is a potential source of operating difficulty and if maintenance free continuous service is to be obtained a considerable amount of detail must be considered in proportioning the various parts and specifying the materials of construction. Probably the best guide to the correct design of this type of equipment is to be found in the various rules and specifications incorporated in the A.S.M.E. and A.P.I.-A.S.M.E. Codes for Unfired Pressure Vessels[13] and in the Standards of the Tubular Exchangers Manufacturers Association.[16]

Substantially all equipment operating at elevated pressures is designed to conform to the rules of one of these codes and most questions of mechanical strength and proportion are fully covered by the various well tested and carefully expressed semi-empirical formulas which are included therein. For convenience in reference Table 1 lists some pertinent paragraphs of the Codes and indicates the component parts to which they apply. Similarly, Table 2 enumerates some A.S.T.M. Standard Specifications[15] which are applicable to heat exchanger work.

Tubes

The active heat transfer surface of an exchanger is of course concentrated in the tube bundle and a large portion of the total cost of most units is spent in the purchase of condenser tubing. In general the film coefficient of heat transfer for a fluid flowing either inside or outside a cylindrical tube varies inversely as some power of the diameter of the tube, and directly as some power of the fluid mass velocity relative to the tube surface. Further, it is geometrically evident that the ratio of the wall surface per unit of length to the internal cross section of a tube varies inversely with the diameter. It follows that, from a theoretical point of view, the use of long, small-diameter tubes is desirable in that it allows the design of compact highly efficient tube bundles involving a minimum amount of materials.

In practice difficulty in cleaning and expanding very small diameter tubes has limited their application and most chemical plant heat exchangers use 1¼ in. o.d., 1 in. o.d., ¾ in. o.d. or ⅝ in. o.d. tubes with ½ in. o.d. and ⅜ in. o.d. tubes reserved for occasional use in special designs.

Tube lengths may vary from 5 up to 25 ft. depending upon the service and type of unit. Here again the theoretical advantages of the high fluid velocities obtainable with long tubes must be balanced against the practical difficulties involved in cleaning and installing very long units.

In some applications scale or other solid matter tends to deposit inside the tubes during operation. Although a correctly designed exchanger with high circulating liquid velocities of from 3-10 ft./sec. will minimize this difficulty it may be necessary to resort to periodic mechanical cleaning in order to keep the heat transfer surface effective. It has been found in practice that a 1 in. o.d. × No. 11 B.w.g. (0.120 in.) tube is the smallest that can be readily bored or scraped clean and that at this minimum diameter the tube length should be limited to 10 ft. if mechanical cleaning is anticipated.

The minimum tube wall thickness necessary to resist internal or external pressures may be calculated according to

TABLE 1—References to Code Design Formulae for Heat Exchanger Parts

Component Part:	A.S.M.E. Code, Sec. VIII 1940 Ed. 1941, 1942 Rev.	API-ASME Code for Unfired Press. Vessels /36	Standards of T.E.M.A. 1941
1. Cylindrical Shells (Int. Press)	Par. U-201(a), (b) Par. U-100(a), (b)	Pars. W.R.F. 309 & 403	Par. T-208-210
2. Dished Heads (Int. Press)	Par. U-36, U-37, U-38	Pars. W.R.F. 310 & 311	.....
3. Flat Cover Plates	Par. U-39	Par. W.R.F. 316	Baffles: Par. T-211 Par. T-225-230
4. Tube Sheets	.....	.....	Par. T-204-207
5. Tubes and Pipe (Ext. & Int. Press)	Par. U-20(c), (d)	.....	.....
6. Nozzles and Attachments	Par. U-59; UA-12-17	Par. W.R.F. 326-330	.....
7. Flanges, Bolting and Gaskets	Par. UA-18-24	Par. W.R.F. 317	Par. T-220-224 T-250-251
8. Fusion Welded Joints:			
(a) Unlimited—X-ray & stress relieved	Par. U-68	Par. W-318, 320	.....
(b) Limited—400 psi. 700°F. Liquids 300°F.	Par. U-69	.....	.....
(c) Limited—200 psi, 250°F.	Par. U-70	.....	.....
9. Safe Working Stresses:			
(a) Ferrous Metals	Tables: U-2, U-2½ (Rev.)	Par. W.R.F. 306 Fig. 1025	.....
(b) Non-Ferrous Metals	Table: U-3 (Rev.)		

TABLE 2—References to Material Specifications for Heat Exchanger Parts. American Society of Testing Materials, 1939 (1940, 1941 Suppl.)

	Carbon Steel	Low Alloy Steel	Stainless Steel	Copper and Alloys	Non-Ferrous Miscellaneous	Cast Iron
1. Plate Work: Shells, Heads, Cover Plates	ASTM—A- 70(39) ASTM—A-212(39)	ASTM—A-203(39) ASTM—A-204(39)	ASTM—A-240(41) ASTM—A-167(41) ASTM—A-176(41)	ASTM—B- 11(33) ASTM—B- 96(40T) ASTM—B- 57(27)	ASTM—B- 25(38T) ASTM—B-127(39T)	.....
2. Plate Work: Baffles, Supports, etc.	Tank Quality ASTM—A- 89(39)	ASTM—A-203(39) ASTM—A-204(39)	ASTM—A-240(41) ASTM—A-167(41)	ASTM—B- 36(41T) ASTM—B- 96(41T)	ASTM—B- 25(38T) ASTM—B-162(41T)	.....
3. Castings: Shells, Heads, Nozzles	ASTM—A- 27(39) ASTM—A-216(41T)	ASTM—A-157(39) ASTM—A-217(41T)	ASTM—A-157(41) ASTM—A-198(39)	ASTM—B- 62(41) ASTM—B-119(40T)	.....	ASTM—A- 48(41) ASTM—A- 47(33)
4. Forgings: Shells, Nozzles, etc.	ASTM—A- 18(39T)	ASTM—A- 18(39T)	.....	.....	.....	.....
5. Flanges	ASTM—A-181(37) ASA—B-16e(39)	ASTM—A-182(39) ASA—B-16e(39)	ASTM—A-182(39) ASA—B-16e(39)	ASA—B-16e(39)	ASA—B-16e(39)	ASTM—A-146(40)
6. Bolting	ASTM—A- 96(39)	ASTM—A- 96(39) ASTM—A-193(40T)	.....	.....	ASTM—B- 98(41)	.....
7. Tubing: Seamless, Welded	ASTM—A-179(40) ASTM—A- 83(40)	ASTM—A-187(40) ASTM—A-199(40)	ASTM—A-249(41T) ASTM—213(40T)	ASTM—B-111(39T) ASTM—375(41T)	ASTM—B-163(41T)	.....
8. Shells, Connections, etc.	ASTM—A-106(40)	ASTM—A-158(40T)	ASTM—A-158(40T)	ASTM—B- 42(41T)	ASTM—B-161(41T) ASTM—B-167(41T)	.....

TABLE 3—Typical Properties and Tolerances of Some Commercially Available Heat Exchanger Tubing

Material	Composition					Treatment	Mechanical Properties: Tensile Strength	Yield Point	Per Cent Elongation	Hardness	Dimensional Tolerance—Seamless: Outside Diameter		Inside Diameter		Wall Thickness
Stainless Steel	**Cr**	**Ni**	**C**	**Misc.**	**Fe**		**psi**	**psi**	**in 2 in.**	**(Brinell)**	**Inches**		**Inches**		**%**
Type #304	18-20	8-10	.08 Max.		Bal.	Annealed	85,000	40,000	55-60	135-185	+.010	—.000	+.000	—.010	±10
Type #347	17-20	8-12	.10 "	Cb. 10XC	Bal.	Annealed	85,000	40,000	45-55	140-180	+.010	—.000	+.000	—.010	±10
Type #316	16-18	14 max.	.10 "	Mo 2-3	Bal.	Annealed	85,000	40,000	40-55	135-185	+.010	—.000	+.000	—.010	±10
Type #317	18-20	14 "	.10 "	Mo 3-4	Bal.	Annealed	85,000	40,000	40-50	150-200	+.010	—.000	+.000	—.010	±10
Type #430	14-18	.....	.12 "	.....	Bal.	Annealed	75,000	45,000	27-30	278	+.010	—.000	+.000	—.010	±10
Type #446	23-30	.....	.35 "	.....	Bal.	Annealed	80,000	50,000	40-50	175	+.010	—.000	+.000	—.010	±10
Copper and Alloys	**Cu**	**Si**	**Zn.**	**Misc.**											
Copper (deoxidized)	99.9	..	...	.....		Light Drawn	40,000	35,000	20	42-111	+.004	—.004	.....	.....	—.000
Silicon Bronze	95.8	1.5	...	Mn 0.25		.....	70,000	55,000	12	45-125	+.004	—.004	.....	.....	—.000
Aluminum Bronze	95	..	...	Al 5		.....	45,000	25,000	40	.....	+.004	—.004	.....	.....	—.000
Red Brass	85	..	15	.....		.....	42,000	15,000	40	50-120	+.004	—.004	.....	.....	—.000
Muntz Metal	61.5	..	38.5	.....		.....	50,000	20,000	40	76-172	+.004	—.004	.....	.....	—.000
Admiralty Metal	70.0	..	29.0	Sn 1.0		.....	50,000	20,000	40	.....	+.004	—.004	.....	.....	—.000
Miscellaneous															
Aluminum	99.9% Aluminum (AC—2-S)					AC—2-S-½H	15,000	.....	35	.....	+.010	—.010	.....	.....	.....
Monel	Ni 67, Cu 30, Fe 1, 4, Mn 1.0, C 0.15					.....	80,000	40,000	40	.....	+.004	—.004	.....	.....	—.000
Inconel	Ni 79.5, Cr 13, Fe 6.5, Cu .20, C 0.08					.....	80,000	40,000	40	.....	+.004	—.004	.....	.....	—.000
Nickel	99.4% Nickel					.....	65,000	20,000	45	.....	+.004	—.004	.....	.....	—.000

the Code formula as indicated in Table 1. Occasionally in high pressure work this consideration determines the tube thickness selected for a given application. However, in most chemical units it is necessary to use a much heavier gauge metal than that indicated by calculation in order to allow for mechanical strength in handling and to provide a margin of safety in case of corrosion or erosion.

The tube walls are obviously the thinnest members in a heat exchanger and consequently they are usually the first to fail. So much is this the case that in severe chemical service several sets of tubes may be corroded or eroded into discard before the other parts of the exchanger show appreciable signs of wear.

Seamless and welded condenser tubing is available in various corrosion resistant metals and alloys,[12,17,18,19,20,21] and tubes are usually supplied by the mills in a heat treated finished condition, cut to length and ready for installation. Some typical physical properties and dimensional tolerances for commercially available tubing are listed in Table 3.

Tube Sheets and Tube Expanding

In modern condenser practice the ends of the condenser tubes are secured in the tube sheets by mechanically straining the tube metal to such an extent that the permanent set in the tube wall is sufficient to form a strong metal-to-metal joint against the inner surface of the tube sheet hole. As this operation involves a plastic deformation of both tube sheet and the tube metal, a considerable amount of care must be exercised both in selecting the proper materials and clearances and in performing the actual expansion.

It is customary to use a dense, forged or rolled tube sheet proportioned according to the rules of Table 1 with ample thickness to resist the push and pull of the tubes in thermal working combined with the hydrostatic forces due to shell and head fluid pressures.

TABLE 4—Minimum Centre-to-Centre Tube Spacing

Tube Diameter: in. o.d.	5/8	3/4	1	1 1/4
Minimum Triangular Spacing: in.	13/16	15/16	1 1/4	1 5/16
Minimum Rectangular Spacing: in.	7/8	1	1 1/4	1 5/16

When cleaned liquids are being handled in the shell it is customary and most economical to space the tube holes at the apices of equilateral triangles. With fouling liquids, rectangular, in line spacing is used in order to provide open lanes between the rows of tubes which permit mechanical cleaning or sand blasting of the outside surfaces. In order that the ligaments between the tube holes may be sufficiently strong to resist deformation during the expanding operation, minimum values for centre to centre tube spacing, as given in Table 4, are usually maintained.

From an examination of the tolerances that may be expected on the outside diameters of commercial condenser tubing as shown in Table 3 it is seen that the tube holes must be slightly oversize in order to allow all of the tubes to pass freely during assembly. This is usually acomplished by drilling the holes to size and then reaming 0.01 in. or less oversize on the diameter.

In modern practice the expanding operation is performed with a roller expander or a series of ball drift pins. Fig. 8 shows a conventional three roll expander which is used almost exclusively for all tubes from 5/8 in. o.d. upwards. With this type of tool it is possible to perform a quick thorough expansion to a controlled depth without overworking or otherwise weakening the joint.

Tubes which are smaller than 5/8 in. o.d. × No. 11 ga. are usually expanded by drifting into the tube sheets. This practice is slower and less satisfactory than roller expanding and is only resorted to because of the mechanical difficulties involved in making roller expanders in the small sizes. The most satisfactory type of drifting for small tubes is effected by using an air hammer to drive a number of ball-headed drift pins similar to those shown in Fig. 8 into the end of the tube. Each pin expands the tube by a few thousandths of an inch and as many as five increasing diameter pins may be used in order to obtain a tight joint. This type of expanding requires much more careful workmanship than does roller expanding. Tube sheet holes should be drilled and reamed to exact dimensions and tubes should be selected by actual measurement with "go" and "no go" gauges in order to ensure an initial close fit which may be tightened by the limited expansion which can be obtained by means of the pins.

The remarkable tightness of a properly expanded tube is shown by the results of the experiments outlined in Table 5. In the first of these, a small rigid tube sheet condenser of 14 in. tube sheet to tube sheet dimensions was built from 2 in. IPS Sched. 80 steel pipe with 1 in. thick stainless steel tube sheets and was equipped with test gauges and pump for 5000 psi hydraulic pressure. Tubes were expanded into plain, ungrooved holes and tested.

In each case, after expanding, a cold water test of 5000 psi was applied without any leakage. Then in order to demonstrate the effect of thermal working, the tubes were alternately heated with steam at 350° F. and cooled with water at 45° F. After 150 cycles the tubes were still tight to full 5000 psi test pressure but after 500 cycles the drifted tubes loosened in both tube sheets while the rolled tubes remained tight.

In the second set of tests a small hydraulic press was used to force short pieces of condenser tubing from expanded seats in various tube sheets. It was found that the holding power of the expanded joint varied with a number of factors and was extremely sensitive to differences in technic. Light drawn copper tubes, 5/8 in. o.d. × No. 16 ga., carefully ex-

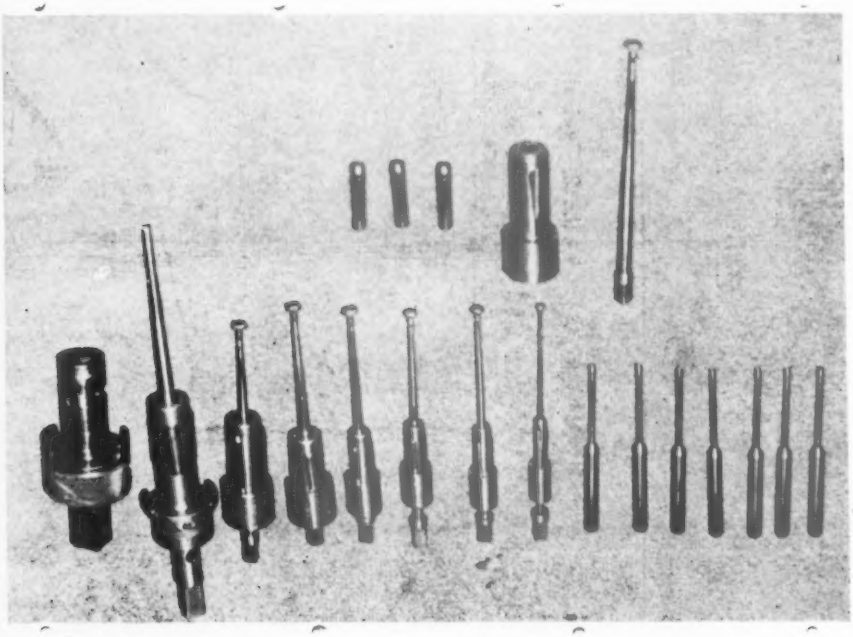
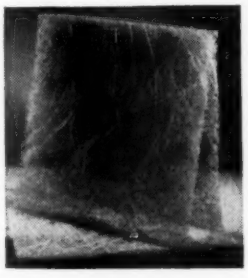


Fig. 8—Conventional three-roll expander and ball-headed drift pins for expanding tubes

"Hot spot" HAZARDS ELIMINATED BY FIBERGLAS* TOWER PACKING

National Petroleum News Photo • Cities Service Refining Corporation—Lake Charles, La., Refinery. The M. W. Kellogg Co., Jersey City, N. J.—Engineers-Contractors.

The Fiberglas Tower Packing being used in three horizontal acid coalescers, 3′ 6″ I.D. x 15′ 0″ long at Cities Service Refining Corporation's Lake Charles, Louisiana refinery affords another example of the many advantages derived from the use of this unique material. Each of the three coalescers contains 78 cu. ft. of Fiberglas Tower Packing. Furnace oil, acid, sludge and water are being satisfactorily handled. The units are operating at the required pressure drops and are adequately meeting all specifications.



Being made of glass fibers, Fiberglas Tower Packing is incombustible, thus preventing "hot spots". Fiberglas Tower Packing affords exceptional surface area—as much as 232 sq. ft. per cu. ft., when packed at a 6-lb. density. And at this density the free volume is 96.1%.

The glass fibers, of which Fiberglas Tower Packing is made, are arranged in jack-straw manner and held together with a water-soluble binder to give them form for easy handling during application. The individual fibers will not absorb moisture, will not rot or decay and are not affected by most acids. And because of its low cost it is not necessary to clean Fiberglas Tower Packing; simply replace it, easily and quickly, with clean packs.

Perhaps you, too, can benefit by using Fiberglas Tower Packing in your fractionation, distillation, evaporation, diffusion, filtration, contact or eliminator process. Samples for experimental work, together with all use and application data available, will be furnished upon request. Write: *Owens-Corning Fiberglas Corporation, 1955 Nicholas Building, Toledo 1, Ohio. In Canada, Fiberglas Canada Ltd., Oshawa, Ontario.*

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ARMY E NAVY

FIBERGLAS TOWER PACKING

*T. M. Reg. U. S. Pat. Off.

TABLE 5—Hydraulic Tightness of Expanded Joints

	Test No. 1	Test No. 2
Nominal Tube Size: in. o.d.	⅝	⅝
Nominal Tube Thickness: B.w.g.	No. 16	No. 16
Thickness of Tube Sheets: in.	1	1
Material—Tubes:	St. St. Type #347 Annealed	St. St. Type #347 Annealed
Material—Tube Sheets:	St. St. Type #347	St. St. Type #347
Diameter of Tube Sheet Hole: in.	0.380	0.755
Outside Diameter of Tube: in.	0.377	0.751
Inside Diameter of Tube, before expanding: in.	0.245	0.620
Inside Diameter of Tube, after expanding: in.	0.260	0.650
Method of Expanding: in.	Drifting No. 1—0.247 No. 2—0.253 No. 3—0.260	Rolled

panded into a 1 in. thick mild steel tube sheet, loosened at approximately 10,000 lb. total axial load.

When an extremely secure tube sheet joint is required, it is common practice to machine two or more shallow rectangular cross section circumferential grooves into the walls of the tube sheet holes. During the expanding the tube wall metal is worked into these grooves and the strength of the joint is thereby considerably increased.

The Ross Heater and Manufacturing Co. have reported[16] some tests which were made on 1 in. o.d. × No. 10 ga. steel tubes rolled into various types of holes in steel tube sheets. A tensile testing machine was used to measure the force required to move the tubes in the tube sheets and the following results were obtained: Plain tube hole, 14,050 lb.; single grooved tube hole, 15,850 lb.; double grooved tube hole, 17,775 lb.; triple grooved tube hole, 18,100 lb. With grooved tube holes and tubes lighter than No. 12 ga. it is reported that the tubes themselves broke before the tube sheet joint loosened. A number of recent papers discuss the theory of the expanded joint and report careful experimental studies on the holding power and hydraulic tightness of steel boiler tubes.[4,6,7,8,9]

If expanded tube sheet joints are to remain tight and alive in continued service it is necessary to ensure that neither the tube nor tube sheet metal are overworked during rolling. To this end it is customary to use tube sheets that are harder and stronger than the tubes, which are usually end annealed in order to ensure suitable physical properties. For instance a light-drawn copper tube expanded into silicon bronze tube sheet makes an excellent durable joint, while a copper tube in a copper tube sheet will be found to give poor service. The tabulation of physical properties in Table 6 indicates the reason for this behavior.

Where complete freedom from leaks at the tube sheet expanding is essential, and in units which are operating under high pressure, tubes are frequently both expanded and seal-welded. However, this practice makes tube replacement difficult and should be avoided wherever corrosive conditions are expected.

Heads, Shell and Expansion Joint

The heads and shell of the exchanger serve as simple cylindrical sheaths, which confine the fluids in their passage through and around the tubes which act as the active heat transfer surface. It is customary to make the shell of ample thickness in either seamless tubing or cast metal and then machine the bore true and straight to a predetermined diameter slightly larger than the baffles and floating head which must pass through it. In this manner units 10-15 ft. long in large diameters with heavy tube bundles can be made with a smooth moving easily removed baffle assembly fitting to less than 1/64 in. clearance. Small baffle clearances are essential if internal baffles are to be used without great loss in efficiency.

The thickness of shells, channels and heads may be calculated according to the accepted Code formulas shown in Table 1, but with most low-pressure units it is necessary to add to the theoretical thickness in order to provide sufficient lateral rigidity to prevent seizing of the tube bundle, which will occur in close-fitted units if there is any deflection in the shell during handling.

The shell and tubes of a heat exchanger must obviously operate at different temperatures and there will consequently be a differential thermal expansion between the two. If the tube sheets are fixed rigidly at both ends of a rigid shell this differential expansion may be sufficient to apply a considerable load on the expanded tube sheet joints. In long units with small-diameter unsupported tubes, the flexural rigidity of the tubes is not great and they may bow and absorb a considerable amount of expansion before loosening in the tube sheets. On the other hand with short units the tubes may be sufficiently rigid to force the expanded joints before flexing.

In practice it is found that over a period of time the tubes of rigid tube sheet units exposed to severe service almost invariably work loose and require re-expanding. In order to avoid this difficulty various types of floating head and flexible expansion joint have been developed and Fig. 9 illustrates some typical designs which are in common use.

The outside packed floating head unit shown in Fig. 9-a allows free movement of the tubes, permits easy removal of the entire tube bundle for repairs and replacements and has no buried joints or gaskets to develop hidden leaks. This design is extensively used in vertical vapor condensers and reboilers using process chemicals in the tubes and a comparatively easily packed substance such as steam, water or brine in the shell in contact with the expansion joint.

The internal floating head type of expansion joint shown at Fig. 9-c has been extensively used in petroleum work but as it contains bolted, gasketed joints submerged in the working fluid which are difficult to test and maintain it is not generally suitable for corrosive chemical service.

In both of the floating head designs illustrated in Fig. 9 the movable tube sheet must be smaller than the internal diameter of the shell in order to allow the tube bundle to be withdrawn. If the floating head cover and channel are bolted directly to the tube sheet a considerable amount of space is lost in the shell and various clamp rings and locking devices have been developed to permit the bolting and backing ring to be added after the tube bundle has been inserted in the shell.

The majority of these locking devices

TABLE 6—Physical Properties—Tube and Tube Sheet Material

	Tube	Tube Sheet
Metal	Cu. 99.9%	Cu. 97.5% Si. 2.0% Sn. 0.5%
Heat treatment	Condenser Annealed	Relief Annealed
Hardness (Rockwell B)	65	110
Tensile strength, psi.	40,000	92,000
Elastic limit: psi.	25,000	80,000
Elongation (% in 2 in.)	45	10

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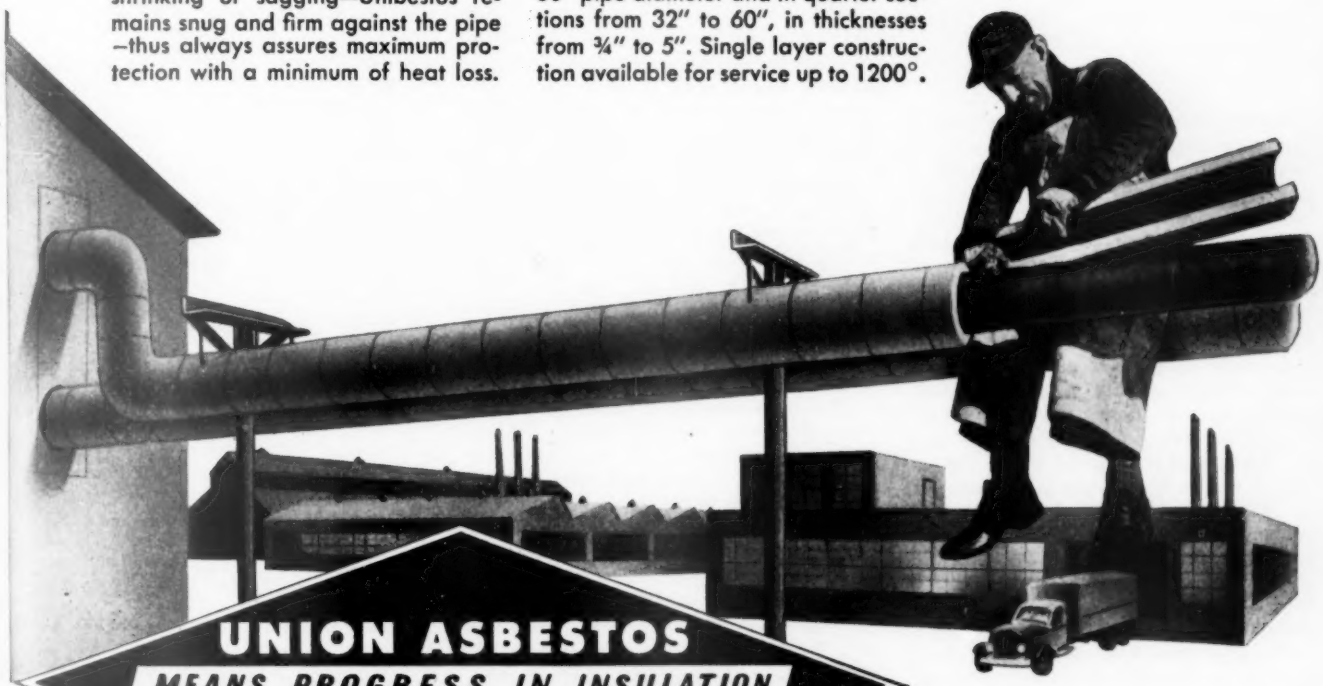

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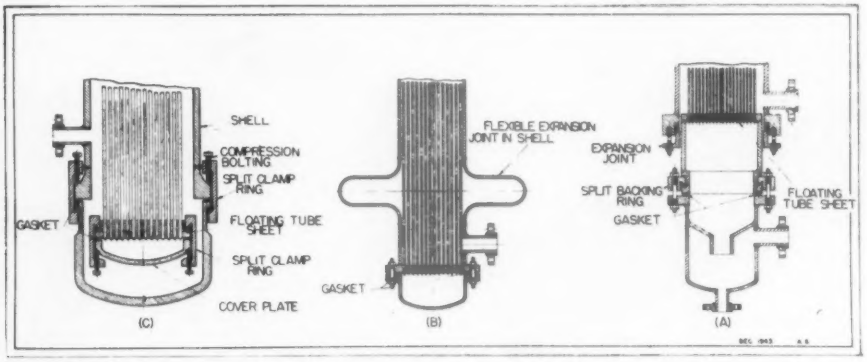

Fig. 9—Types of floating heads and flexible expansion joints

operate on the same principle and consist of a heavy ring bent to an inside diameter slightly less than the outside diameter of the floating tube sheet, drilled to take the necessary bolting and split into two semi-circular halves in order to allow them to be fitted at the back of tube sheet. Some designs are grooved to lock into place and some depend merely upon the bolt loading for rigidity; however, they may all be completely removed when the tube bundle is withdrawn from the shell.

The flexible shell unit shown at Fig. 9-b may be readily spun or forged in most metals and if a sufficiently large ratio of expansion joint to shell diameters is maintained a flexibility sufficient to allow normal thermal working may be obtained. This type of joint is especially well suited to units handling chemicals in the shell and as there is no packing or gasket to maintain it remains permanently tight and free from leaks.

Baffles

Baffle plates serve to guide the flowing fluids through comparatively narrow channels around and through the tubes, thereby ensuring the turbulent high velocity flow necessary for good heat transfer. In this service they are subject to both corrosion and erosion and if they are inadequately supported may develop vibrations which in severe cases have been known to wear through the tube walls.

In order to prevent mechanical difficulties baffles should be amply thick, rigidly supported, and fabricated from a thoroughly resistant material which may be expected to outlive the tubes. In order to ensure the proper functioning of the baffles and prevent by-passing and consequent poor heat transfer it is essential that the clearance between tubes and baffles, and baffles and shells be held to a minimum consistent with ease in assembly. Clearances of 0.01 or 0.02 in. on the tube hole diameters and of 1/64 in. on the shell diameter can be obtained without undue difficulty. Most modern units with transverse baffling in the shell side employ segmental type baffles with cross flow through the tube bundle. Orifice type baffles were once frequently used but unfortunate experience with blocking and erosion has caused them to become obsolete for all but special applications.

Longitudinal baffles with various devices for sealing the long, shell to baffle, internal joint have been developed but these are nearly all unsatisfactory in corrosive chemical service. In large diameter units of flexible shell construction a satisfactory longitudinal baffle may be installed by welding to the shell. However, in general in chemical service it is best to design a number of small simple units for use in series flow instead of one large elaborately baffled exchanger. The latter will show some initial economy in materials and fabricating cost but may lose the greater part of its efficiency after a short period when corrosion has opened up the baffle clearances and leakage develops.

Bolting and Gaskets

The design of the various gasketed joints of a heat exchanger is adequately covered by the recommendations of the various codes, and the calculation of stresses and estimation of proportion has been described in a number of papers.[11,15,24] In chemical work at low pressures wide soft asbestos gaskets are frequently used. This type of material requires only a small unit compression (2000-4000 psi) and may therefore be made tight with light bolting. It is, however, very susceptible to failure under pressure and should be avoided wherever operating pressures of over 100 psi are encountered.

High pressures or temperatures necessitate the use of confined metal clad asbestos or soft metal gaskets. With this design heavy bolting and rigid flanges are essential in order to obtain the high unit gasket compression (10,000-20,000 psi) required for initial tightness with hard surfaced gasket materials.

The great majority of so called "gasket troubles" are due to incorrect joint design involving too little gasket compression, sprung flanges of inadequate torsional rigidity or overpulled strained bolting. Careful, conservative design of flanges and bolting is one of the most essential factors in heat exchanger design and wherever possible standard (ASA. B16-e-1939) flanges, known to be adequately proportioned should be used.

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A Machine for Performance Tests of Antifriction Bearing Greases*

*By Paul G. Exline** and S. A. Flesher***

A grease evaluation machine is described for testing the performance of antifriction bearing greases in ball bearings under simulated service conditions. Speed, load and temperature can be chosen and closely controlled. Temperatures are automatically recorded and give an indication of grease failure by a sudden rise. The greases are also examined periodically to follow developments and also to declare grease failure if the race paths are found dry without temperature rise. Typical examples of notes taken during tests are given to illustrate their use in evaluating the greases. The degree of test reliability is indicated in tables showing results in duplicate tests.

THE extreme difficulty of evaluating antifriction bearing greases in service is well known. The service performance of the grease depends upon three classes of variables; 1, the properties of the grease; 2, the operating variables and 3, the mechanical variables such as fit, clearance, surface finish, etc. The grease manufacturer usually can obtain little information on either of the latter two, while even the user himself rarely has information on the third group.

Routine specification tests of greases are not capable of providing information on which to base predictions of performance in field service. There is thus a great need for test machines and procedures which will permit a more accurate evaluation of the grease by the manufacturer. This paper describes a machine which has been used in an attempt to secure such an evaluation.

The ideal grease evaluation machine would be one by which the grease could be subjected to a wide range of operating conditions under close control. The tests should be completed in a reasonably short length of time and repeat tests on the same grease should agree closely. Finally, the correlation between machine results and service performance should be good. We are still far from this ideal, but our experience with this machine has enabled us to see some of the pitfalls and has pointed out several promising points of attack.

Apparatus

The grease evaluation machine consists essentially of a device for rotating ball bearings, packed with the test grease, at constant speed, load and temperature. The bearings are mounted on stationary, parallel spindles and the outer races are rotated by steel wheels mounted thereon.

A diagram of the bearing mounting is shown in Fig. 1. Two ball bearings are placed on the spindle, 1, with a light press fit. The flat rimmed wheel, 2, has a long hub which contains a cylindrical spacer, 3, into which the outer races of the bearings are pressed. The bearings are confined in the hub by two seal plates, 4, which in turn are forced inward by the two end plates, 5. A thin aluminum gasket is placed between each bearing outer ring and the adjacent seal plate. These gaskets are 0.005 in. thick and wide enough to cover the face of the outer ring. They are used as seals to prevent loss of oil from the grease by leakage. The bearings are separated a distance of 2¼ in. by a deeply grooved separator, 6. The purpose of the grooves is to prevent migration of grease from one bearing to another in order to permit use of different grease samples in each bearing.

A cartridge heater, 7, is placed in an axial hole drilled in the spindle. Two circular heaters, 8, are mounted around each end of the hub to provide additional temperature control. The rear heater is supported by arms from the spindle base and the front heater from a plate clamped to the end of the spindle. Each of the three heaters has independent voltage control for adjusting the input. Bearing temperatures are measured by thermocouples placed with their junctions adjacent to the inner race of each bearing. The method of introducing these thermocouples is shown in the vertical plane in Fig. 1, although in the machine they are actually in the horizontal plane, 90 deg. from the direction of loading.

Two of these wheel units are mounted in each machine as shown in Fig. 2 and are enclosed in an insulated housing. A pulley attached to the upper wheel is driven at 750 r.p.m. by a motor mounted outside the housing. The spindle of the lower wheel is attached to one end of a compound lever system so that it may be forced against the upper wheel and driven by contact on the smooth rim surfaces. In the photograph the weight, 1, is suspended from one end of the lever system indicated by the arrows, 2. This is counterbalanced so that with no weight on the pan, the lower wheel spindle will remain in a horizontal position when assembled for a test run.

The upper spindle is mounted on a bar which can be adjusted by the two screws shown projecting from the top of the machine. This makes it possible to adjust the contact after load has been applied so that the force is transmitted uniformly across the width of the wheels. Once the adjustment has been made, the upper spindle support is located in position for the remainder of the test. The lever ratio is 100:1 and most of the test work has been carried out with a load of 1000 lb. per bearing, requiring a 20 lb. weight on the pan.

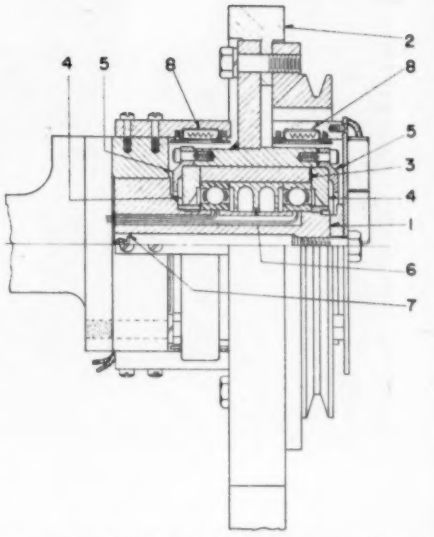

Fig. 1—Detail of bearing mountings for grease evaluation machine

A sensitive thermostat is mounted in the housing and controls the bearing temperatures to several degrees Fahrenheit. Bearing temperatures are recorded by means of a multipoint recording potentiometer which not only gives a constant indication of the accuracy of control, but also indicates failure by a temperature rise.

Fig. 3 shows the parts in greater detail, the lower wheel having been removed to expose the spindle and the lower rear ring heaters. In this view, 1 is an oil line from a drop feed oiler which maintains a film of oil on the rims during the test, 2 is the sensitive element of the thermoregulator and 3 shows the location of the bearing thermocouples.

Bearings

The bearings are SKF No. 210 deep grooved ball bearings, 50 mm. I.D. by 90 mm. O.D., containing ten ½ in. balls. It has been found preferable to use bearings obtained from a single manufacturer in order to eliminate manufacturing variables. The bearings themselves must be selected so that when mounted in the machine they will all have adequate internal clearance. The variables involved in this selection are hub diameter, which varies from wheel to wheel; the running clearance of the unmounted bearing and to a lesser extent the outside diam-

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**Gulf Research & Development Co., Pittsburgh.

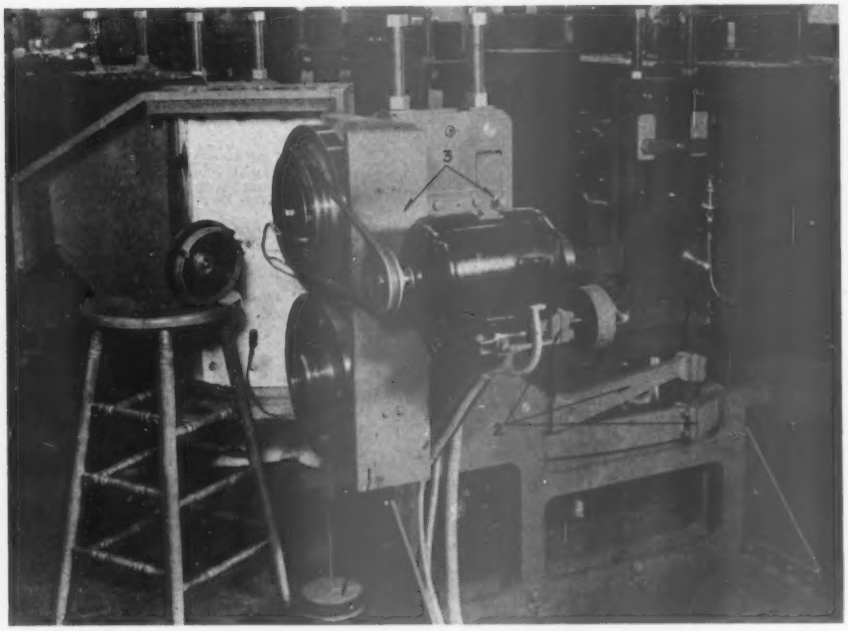


Fig. 2—Grease evaluation machine

eter of the bearing. In order to be able to make the proper bearing selection, it is necessary to have available a fairly large stock of bearings.

The internal bearing clearance is estimated from the "end play" or lateral freedom of the inner race when the outer race is fixed. This is measured by a dial indicator mounted on a jig which is supported by three legs resting on the end of the hub containing the bearing. The indicator spindle then touches a point on the end of the inner race of the bearing. The inner race is pulled firmly against the outer race at a point opposite the indicator. While held in this position the side of the race under the indicator is moved up and down. With no running clearance the dial indicator will show movement, but it will be small and proportional to the force applied. With clearance present the race will move freely over a short distance. If this free movement is less than 0.004 in. or 0.005 in., the bearing is too tight and should not be used. Values larger than this have no apparent effect on the results.

Clean Bearings Essential

After selection of the proper bearing, it must be cleaned to remove all traces of the original grease. Cleaning is done by rinsing in naphtha and blowing with an air jet, repeated several times. If the ball and races do not appear mirror clean after this treatment the bearing is then rinsed in acetone followed by application of the air jet. The air jet is used to remove the solvent, containing a small amount of grease, before it can evaporate on the surfaces.

The amount of grease placed in the bearing is determined by weighing the bearing before and after its application. The grease is placed in the bearing by a narrow bakelite spatula. It is spread uniformly around the bearing with as much as possible placed on the races themselves.

The charged bearings are installed in the wheels, one at each end of the hub with the separator between, by means of a press. Under these circumstances, the bearings project a trifle out of the hub so that the end plates, upon being fastened by means of screws, contact the outer races of the bearings rendering the entire assembly secure in the wheels. The wheels are then pushed onto the spindles, previously very slightly oiled, and the outer heater rings screwed to the ends of the spindles. With proper adjustment of the loading screws and heater controls, the machine is ready for its run.

At periodic intervals, whose length is determined by the temperature and the grease condition, the machine is stopped and the wheels removed for inspection of the bearings and the grease. The bearings themselves are not removed from the wheels during this examination. The condition of the grease and bearing are noted as well as the torque necessary to rotate the inner race by hand.

A test may be terminated for one or more of four reasons:

1. A rise of the indicated temperature amounting to more than 15° F. above the control temperature.
2. Dry race paths.
3. At the end of a predetermined time.
4. Appearance of pits in the balls or races.

At the periodic inspections as well as at the termination of the test, grease conditions are carefully observed and noted. Also a watch is kept for signs of bearing damage. It is obviously not sufficient to wait merely for some outward symptom such as temperature rise to draw conclusions regarding the merits of a grease. All aspects that may cast some light on the lubricating deficiencies or deterioration of the grease should be studied during the run. If one is to make a wise choice of lubricant in a given operation, he must know as far as possible the behavior of that lubricant during its term of service in that situation.

Aspects Observed and Studied

Darkening of a grease is one of the first signs of oxidation. With this usually comes an increase in viscosity, often complicated by separation and melting at high temperatures. Even though it is a grease whose melting point is above the operating temperature and which channels nicely at first, it will probably become quite fluent after some running. All these changes should be noted from time to time. The conditions when the machine is stopped and cooled are extremely important. The torque at high temperature is usually low, but after cooling, especially if the grease is pooled at the bottom, it may be dangerously high.

On the other hand, if the grease consistency is found to be satisfactory throughout the test, it is very important to observe the situation inside the bearing. The race paths may be starved or gummed up. The amount and condition of the lubricant should be noted and the bearing felt for torque and smoothness. If the bearing is found damaged, the type of damage—discoloration, scaling, pitting, etc.—should be recorded, and correlated, if possible, with grease conditions.

Some examples of notes made during tests will serve to illustrate the points enumerated. Table I shows three tests which are typical, and also contrasting. The differences were due to differences in greases as all three were run under like conditions. These examples were chosen not only to show the adopted procedure but to illustrate the absolute need for periodic inspections in arriv-

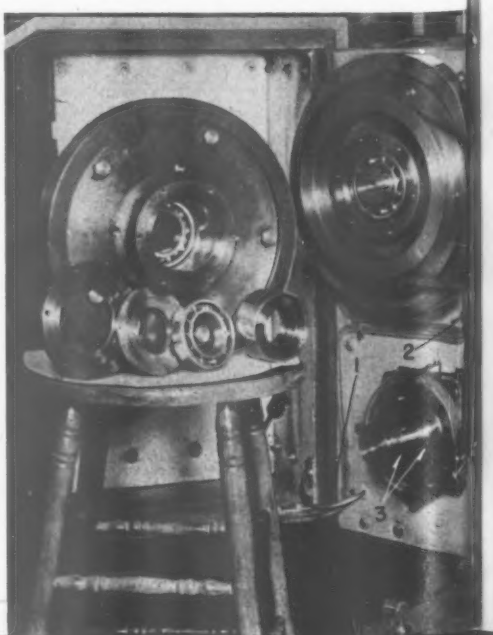
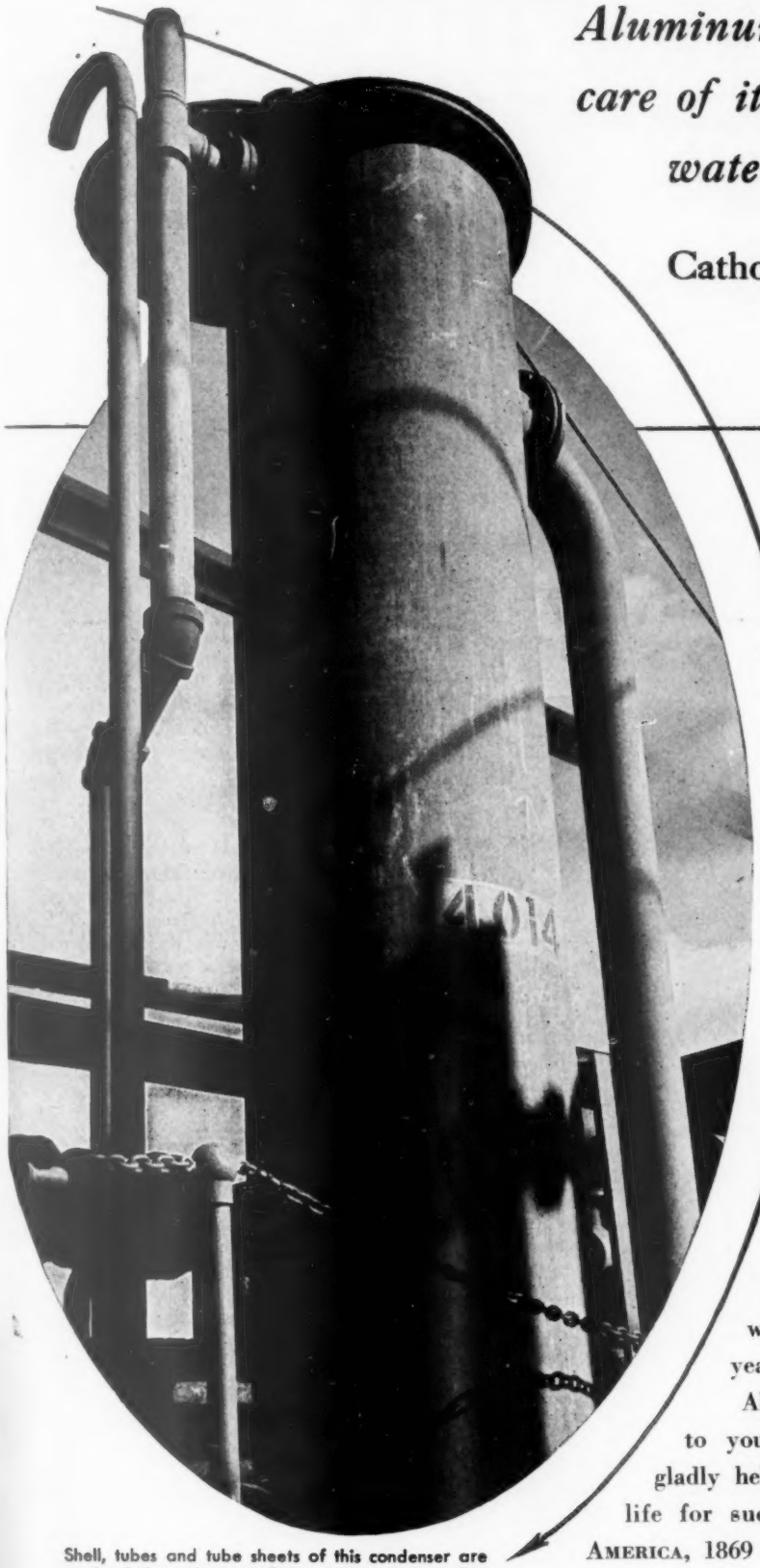


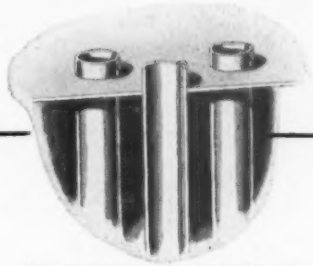
Fig. 3 — Grease evaluation machine, showing assembly parts



Shell, tubes and tube sheets of this condenser are made of Alcoa Aluminum. Opened for inspection after two years, all were found in excellent condition.

Aluminum Condenser takes good care of its charges, but the cooling water treated it rough . . .

Cathodic Protection cured that



A zinc wire provides cathodic protection for each aluminum tube.

Organic liquids condensed in this aluminum alloy condenser get along fine with the aluminum. Their purity and color are not affected. They, in turn, do not attack the aluminum. But, up to 1942, there was one discordant note in this happy arrangement; the cooling water attacked the insides of the aluminum tubes.

Solution-potential measurements on this cooling water, at Aluminum Research Laboratories, indicated that zinc would cathodically protect the aluminum against attack. Zinc wires were accordingly installed in the tubes, as shown in the above sketch. That was in 1942. Two years later, inspection found the interiors of the tubes still bright and showing no signs of attack. The wires looked good for at least another two years of police work on this job.

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TABLE I—Examples of Notes Taken During Tests (Load, 1000 lbs.; r.p.m., 750; temp., 275°F.; amount of grease charge, 15 grams)

TEST EXAMPLE NO. 1

185 hours—(hot)—Black. Almost all fluent. Low viscosity. Low torque. Races flooded.
(cooled)—Same.

350 hours—(hot)—All fluent. No other change.
(cooled)—Medium or low viscosity.

519 hours—(hot)—Channelled. Races well lubricated.
(cooled)—Gummy, but good in races. Moderately low torque.

667 hours—(hot)—No change.
(cooled)—Very gummy, but very good in races. Low torque.

764 hours—(hot)—No change.
(cooled)—Very gummy. Some hard gum. Races well lubricated with thin oil or grease. Test terminated for examination and further reference. Bearing apparently undamaged.

TEST EXAMPLE NO. 2

192 hours—(hot)—Almost black. Mostly channelled, but appears to have been fluent. Low torque. Races well lubricated.
(cooled)—Lightly gummy. Moderately high torque.

425 hours—(hot)—Black. Semi-fluent. Low torque.
(cooled)—Pretty gummy. Very high torque.

542 hours—(hot)—Channelled. Appreciable amount in races. Medium torque.
(cooled)—Very gummy all around. Dangerously high torque.

659 hours—(hot)—Slight amount in races. Low torque.
(cooled)—Hard gum. Very viscous in races. Moderately high torque.

758 hours—(cooled)—Races dry. Very hard gum near races. Hard gum away. Approximate time to grease failure, 758 hours. Bearing slightly discolored.

TEST EXAMPLE NO. 3

161 hours—(hot)—Dark brown, some very. Very well channelled. Well lubricated. Low torque.
(cooled)—Rather high consistency, but little different from new. Softer in races. Moderately low torque.

349 hours—(hot)—Dull brown to very dark. Little in races.
(cooled)—Harder. Low torque.

518 hours—(hot)—Very dark brown to black. Little in races.
(cooled)—Very gummy near races. Pasty in races, causing some binding. Torque about medium, but irregular.

608 hours—(cooled)—Races dry and crusted. Very gummy near races. Rest gummy and a good deal hardened, but would lubricate well at high temperature if it were in races. Approximate time to grease failure, 608 hours. Bearing slightly discolored.

ing at a reliable appraisal of a grease.

Each of the three greases represented reveals some desirable characteristics. Each one also shows some weakness, but little of this information would be obtainable from an uninterrupted run to the end. Too often a grease is recommended and chosen in service on the basis of certain desirable characteristics while important characteristics which show up only in operation remain unknown and unconsidered. The procedure given in this paper tends to minimize this discrepancy.

In Sample No. 1 the fluency, which was probably due to separation, would obviously be bad in certain applications. Before the end of the test the situation changed into a happy one in which the bulk of the grease remained channeled and firmly fixed, and "bled" a thin oil or grease to the race paths, and considering the high temperature, this situation was well sustained from the standpoint of time. However, for a heavy load at high temperature this lubrication might be too thin. The one in Sample No. 2 could be better, but in this one there is a dangerous point to note. During a certain stage of its life, when the machine was stopped and cooled the grease pooled and thickened so that it was almost impossible to move the inner race by hand. With such a starting torque in certain machines it would be impossible to restart, or ruinous to do so, without first reheating. The important observations to make in Sample No. 3 are that while the lubrication requirements were nicely met for a fair period of time, the lubrication gave out in the races long before the grease outside reached a bad state of deterioration.

The criterion of grease failure is lack of lubrication manifested either by a temperature rise or by dry bearing races.

When failure is associated with a temperature rise of the bearing the change of temperature is usually quite rapid and is accompanied by a shrill screeching as if the bearing were wearing out. Detection of failure of this type involves no difficulty.

The indication of a dry bearing is sometimes troublesome because the bearing may run dry for some time with no outward symptoms of dryness. There is probably some protective coating in such cases, but the bearing is not lubricated in the ordinary sense.

It has been observed in scores of such instances that temperature rise and rapid wear may set in at any moment, or the test may continue for hours or even weeks depending on the operating temperature. The effect is apparently "triggered" by local action between the balls and races or between the balls and separator, following which it spreads rapidly throughout the bearing. Within an hour the bearing is in a bad state of ruin, often called "burnt up."

It has also been observed that if any trace of lubricant that still retained any fluency was present on the race paths, failure never occurred immediately. In many cases the runs continued for a long time with little or no noticeable change in the races, especially if the film, even though thin to the point of invisibility, was not gummed up. These observations indicate that the race paths must be quite dry before any appreciable temperature rise or wear begins.

The final determination of dryness is sometimes difficult. It requires experience and involves the use of the three senses of sight, hearing and touch. As an example, many times no lubricant has been visible on the race paths, but the bearing is quiet and it feels padded or cushioned when pressure is applied by hand and the bearing rotated slowly. This behavior gives way to one of harshness as the races become dry. The bearing may hiss or screech as it is rotated, the race paths become irregularly spotted or glazed, or look dulled though not necessarily damaged. When rotated by hand it feels as though the balls were rolling over tiny obstructions. This transition usually comes with sufficient suddenness that one can fix the time with reasonable accuracy if the inspections are well timed.

Occasionally relatively large pieces of metal will chip or spall from the surfaces of the balls or races. This is not necessarily associated with grease failure. In fact, it occurs only in the presence of grease. Its occurrence is easily detected

TABLE II

(Grease Test Results Showing Comparisons of Failure Times in Duplicate Tests)
Load—1000 lb. r.p.m.—750
Temperature—330°F.
Amount of Charge—15 grams

Grease	Test No.	Approx. Time to Failure, Hours 1st Test	2nd Test
4	672	63	63
24	664	74	74
11	620	96	114
23	662	105	105
14	812	115	115
30	814	130	115
2	674	112	137
1	676	125	125
32	638	126	126
31	636	132	132
8	750	144	151
5	700	148	159
20	690	143	165
10	748	144	164
17	688	134	175
12	622	150	162
3	670	160	160
13	686	145	175
9	728	162	162
29	630	154	173
22	738	174	162
26	692	165	176
28	628	173	173
25	612	154	186
6	698	181	159
27	614	186	176
16	648	186	186
18	712	188	200
19	710	174	212
15	646	198	210
7	730	252	238
21	740	248	248

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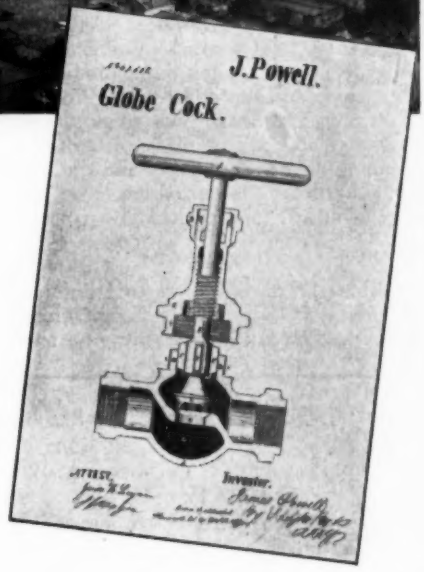

To meet the many new and exacting demands of the petroleum refining industry, Powell Engineering has developed a complete line of valves for cracking, isomerization, alkylation, hydrogenation, dehydrogenation, polymerization and all catalytic processes. These valves—Globe, Angle, Gate, Y, Check, etc.—are available in carbon steel and various corrosion resistant alloys.

The valve shown here was recently developed by Powell Engineering to satisfy specific requirements. It is a class 300-pound Cast Alloy Steel Gate Valve designed to handle high temperatures. It has 12" port size venturied to 20" size end flanges to accommodate insulated pipe and is equipped with a top-mounted, enclosed, explosion proof, electric motor operator for quick, positive opening and closing.

POWELL VALVES

by the noise or roar of the balls rolling over the pits.

It is important to differentiate between such a failure of the bearing and a true failure of the grease. A well lubricated bearing will eventually fail through pitting if run long enough under a heavy load. The number of bearings failing in a given time will follow a probability curve and in testing greases the conditions must be chosen to secure a low probability of bearing failure.

In some tests when the presence of pits had made itself heard the inner ring was rotated on the spindle to place the pits on the unloaded side and the test continued. This still left the particles of metal in the grease yet the results show no great difference, on the average, in grease condition or grease-failure time between the pitted and unpitted bearings.

The opinion is expressed here that there are two separate problems involved: one concerning the endurance of the grease and the other the anti-pitting protection afforded by the grease. There is some evidence that this protection is a function of the oil viscosity and the soap content, but a discussion of these factors is outside the scope of this paper.

Reproducibility

Table II lists the hours to failure for two tests on each of 32 different grease samples. These tests were run at a temperature of 330° F., a speed of 750 r.p.m. and a load of 1000 lb. per bearing. In all cases the initial grease charge was 15 grams. The test numbers given are for the first run, the duplicate run being given the next consecutive number. The greases are listed in the order of increasing time to failure, although the table is not intended to be used as a rating of the greases.

Failure was indicated by dryness of the races with three exceptions in which the indication was temperature rise of the bearing. The greatest percentage difference in times to failure was between tests Nos. 688 and 689. The average percentage deviation from the mean for all the tests was 4%. Such a low value is due largely to the fact that the two tests were run simultaneously in the same wheel, the inspection periods coincide, and judgment of failure in one bearing undoubtedly influenced the judgment regarding the other bearing, particularly in critical cases.

At lower temperatures the running time increases enormously. In order to save time more reliance is generally placed on the notes taken during the periodic inspections and the tests discontinued before they are terminated by grease failure. Table III lists a group of tests on the same greases as Table II with all conditions the same except that the temperatures were 275° F. Those marked with an asterisk were discontinued shortly after 750 hours' running time. In this table the greases are listed in the same order as in Table II. It will be noted that in 5 of the 6 cases where failure occurred in both tests, the times were identical. This again is due partly to the fact that both tests were run simultaneously in the same wheel and the inspection periods coincided.

TABLE III—Grease Test Results Showing Comparisons of Grease Conditions in Duplicate Tests

Load—1000 lb. r.p.m.—750
Temperature—275 F.
Amount of Charge—15 grams

Grease	Test No.	Approx. Time to Failure, Hours 1st Test	2nd Test	Grease Condition 1st Test	2nd Test
4	684	246	246	E**	EF**
24	No test				
11	632	654	563	DE & E	DE & E
23	No test				
14	777	768	768	E	E
30	821	771*	771*	DE	D & DE
2	668	758*	758*	E	DE
1	666	758*	758	DE & E	E & EF
32	624	764*	764*	E	DE & E
31	618	586*	586*	DE	DE
8	752	603	603	E	E
5	702	763*	763*	DE	DE to E
20	696	768*	768*	DE	DE & E
10	754	504	504	E	E
17	682	762*	762*	E	E
12	634	754*	608	D & DE	D & DE
3	680	767*	767*	DE	DE
13	678	767*	600	D & DE	D & DE
9	726	667	767*	EF	D
29	616	753*	753*	DE	DE
22	744	764	764*	E	DE
26	694	768*	768*	D & DE	D & DE
28	608	768*	768*	E	DE & E
25	610	588*	588*	DE	DE
6	704	763*	763*	D to DE	DE
27	606	768*	768*	DE	DE
16	656	759*	759*	DE	E
18	716	766*	766*	E	E
19	718	766*	712	E	DE to E
15	654	759*	759*	D to E	DC & D
7	734	651	651	E	E
21	No test				

* Test terminated before grease failure.
** Letter symbols: C, darker and more viscous; D, gummy; E, hard gum; F, powdered.

TABLE IV

(Life-Test Comparison Between Sodium and Calcium Base Greases)
Load—1500 lb. r.p.m.—750
Temperature—250 F.
Amount of Grease Charge—7 grams

Base	Grease	No. of Tests	Avg. Hours To Failure
Sodium	A	3	1120
Sodium	B	2	1020
Sodium	C	1	680
Sodium	D	1	620
Calcium	E	3	188
Calcium	F	2	102
Calcium	G	2	74

The letter symbols indicating the condition of the grease on the lands and separators were arbitrarily chosen early in the program and have the following somewhat loose meaning:

A. Like new
B. Darker
C. Darker and more viscous
D. Gummy
E. Hard gum
F. Powdered

When this rating was found to be inadequate, combinations of letters were used to indicate intermediate conditions. Although this is largely a subjective method of indicating condition, all ratings throughout the entire program have been made by the same operator (S. A. Flesher).

Six grease evaluation machines have been in nearly constant operation during the past four years. The tests reported in Table II were all carried out in one machine which was maintained at 330° F. Three of the remainder were maintained at 275° F. and were used in collecting the data shown in Table III.

It was thought desirable to find out what results would be obtained with these machines in tests on low-temperature greases run at a high temperature. Three such greases (calcium-soap base) were chosen and several tests run at 250° F. to grease failure. These are tabulated (Table IV) for comparison with results obtained under the same operating conditions on four sodium-base greases, which are greases recommended for high-temperature service.

Conclusion

The grease evaluation machines described have been designed and operated in an attempt to secure a method as objective as possible for evaluating greases. The achievement of this goal has been limited since the method largely depends on the skill and judgment of the operator. The machines have been of great value in indicating the influence of various changes in grease composition upon its performance.

New Volume Correction Factors Issued for C_4 Hydrocarbons

Basing of the New Data Upon Vapor Pressures Instead of Specific Gravity May Limit Their Application in Shipping and Billing Practices, It Is Believed.

By D. P. Thornton Jr.
Assistant Editor, NPN Technical Section

NEW tables of volume correction factors for C_4 hydrocarbons and their mixtures have been compiled by Dr. C. S. Cragoe and published by the U. S. Bureau of Standards as Letter Circular LC-757, "Volume Correction Factors For C_4 Hydrocarbon Mixtures," at the request of Rubber Reserve Corp.

The compilation applies only to C_4 hydrocarbons, their mixtures, and mixtures of C_4 hydrocarbons containing limited amounts of C_3's and C_5's coming within the range 40 to 80 psia vapor pressure at 100°F., with specific gravities ranging from 0.56 to 0.63 at 60°/60°F. More specifically, it is intended to apply to such hydrocarbons as are used in aviation gasoline and synthetic rubber manufacture; i.e., largely C_4 unsaturates.

The tables presented are intended to supplement a set of density tables previously published by the Bureau as Letter Circular LC-736, "Liquid Densities of Eleven Hydrocarbons Found in Commercial C_4 Mixtures," also by Dr. Cragoe, and in addition "to supersede various tables of volume correction factors which are not sufficiently accurate to permit precise computations of quantities of C_4 mixtures for use in commerce, particularly in the manufacture of aviation gasoline and 1,3-butadiene."

With reference to existing tables (National Standard Petroleum Oil Tables—National Bureau of Standards Circular C410; Handbook of Butane-Propane Gases, 2nd Edition; N.G.A.A. Standard Factors for Volume Correction and Specific Gravity Conversion of Liquefied Petroleum Gases and Volatile Gasolines—Technical Standards of the Natural Gasoline Assn. of America) the circular takes the following position:

"A comparison of the liquid volume correction factors given in NBS LC-736 for C_4 mono-olefins and 1,3-butadiene shows differences from . . . existing tables which exceed one unit in the second decimal place. For this reason, existing tables are considered unsatisfactory for general application to C_4 mixtures containing hydrocarbons of other than the paraffin series. All existing tables are based upon and presuppose mixtures which are predominantly paraffin series hydrocarbons and hence do not apply with the same accuracy to mixtures containing other types of hydrocarbons which are being produced now and seem likely to be produced in increasing amounts in the future."

Tables of the new circular are based exclusively on "extensive data available in the literature for individual hydrocarbons, in the absence of adequate experimental data on the thermal expansion of C_4 mixtures covering wide variations in composition."

Tables Based on Vapor Pressure

As a premise for basing the tables on vapor pressure rather than specific gravity, as are all other tables of volume correction factors, Dr. Cragoe cites the correlation of specific gravity with coefficient of expansion shown in Fig. 1. It is apparent from study of this curve that volume corrections based on specific gravity for paraffin C_3's to C_5's fall upon the curve, while those for mono-olefins, diolefins, acetylenes and cycloparaffins deviate markedly.

In comparison, Fig. 2 indicates that vapor pressure at 100°F. vs. coefficient of expansion at 60°F. for C_4 to C_5 hydrocarbons (only) gives a much closer correlation.

For its purposes, Dr. Cragoe and the Bureau have taken the close correlation of vapor pressure with coefficient of expansion shown in Fig. 2 as a basis for the table of liquid volume correction factors published in Letter Circular LC-757. These factors are ratios of the volume at 60°F., V_{60}, to the volume at t°F., V_t, for the same mass of liquid, which are equivalent to ratios of density, D. The ratios vary with the temperature, t, approximately according to the relation F (liquid) $= V_{60}/V_t = D_t/D_{60} = 1 - A(t - 60) - B(t - 60)^2 - C(t - 60)^3$, where A, B and C are constants for a specified liquid and the constant A represents the coefficient of expansion at 60°F.

A second important table of LC-757 gives vapor volume correction factors, for use in determining the volume of liquid vaporized to fill the void left when liquid is withdrawn from a closed container or condensed when liquid is admitted to a closed container. These factors are ratios of the volume of liquid at 60°F., V_{60}, to the volume of the same mass in the vapor

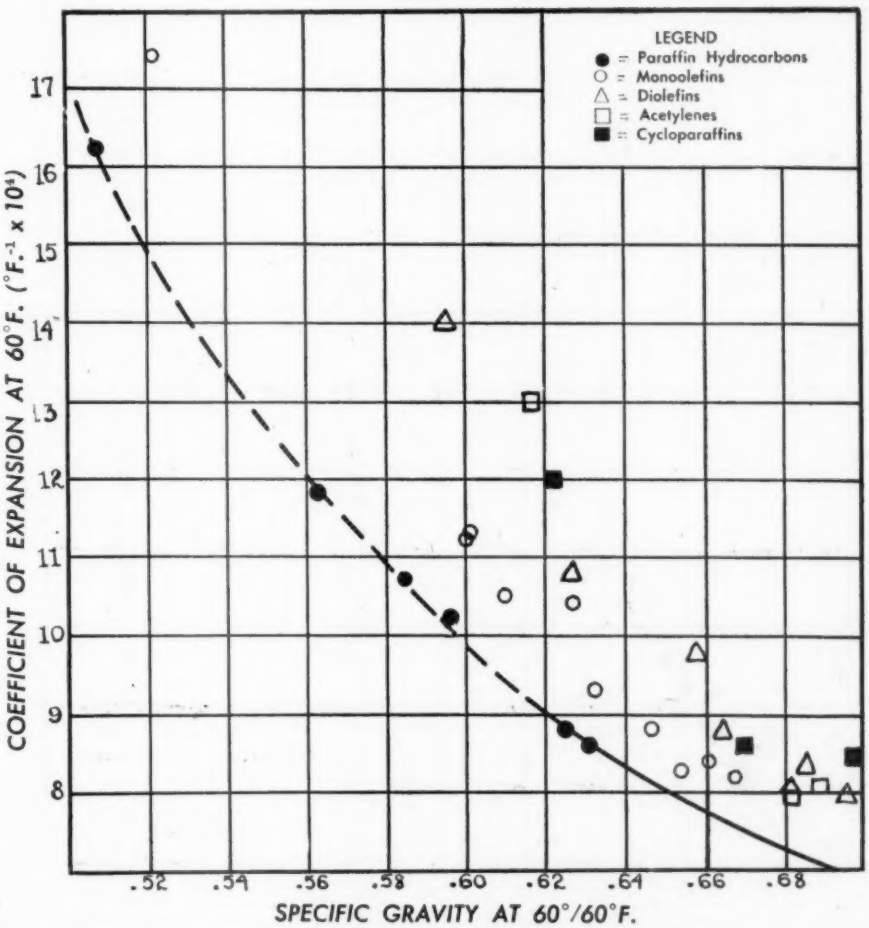

Fig. 1—Correlation of coefficient of expansion with specific gravity for hydrocarbons of paraffin, olefin, diolefin and cycloparaffin series. Paraffins correlate well but hydrocarbons of other series with equal gravity have greater expansions by as much as 40%. Solid line denotes correlation taken from NBS Circular 410

state at a specified pressure, V_p, which are equivalent to ratios of density D; thus:

$$F\ (vapor) = V_{60}/V_p = D_p/D_{60}$$

The density was calculated according to the method outlined in NBS LC-736[1]. The values of vapor density of C_4 hydrocarbon mixtures used as a basis for the table of computed vapor volume correction factors were made consistent with values for the vapor density of individual C_4 hydrocarbons at the same pressure and corresponding liquid specific gravity at 60°/60°F. In these calculations it was assumed that the vapor was in contact with the liquid phase and that the temperature corresponding to a specified pressure was fixed by the relation between vapor pressure and temperature given.

Usefulness of the Tables Limited

It would appear from the limitations cited (C_4 hydrocarbons and mixtures, only minor amounts of C_3 and C_5 hydrocarbons, and specific gravity range 0.56-0.63 at 60°/60°F.) that the new tables will not be particularly useful to the natural gasoline and l.p.g. divisions of the oil industry. Instead it is conceivable they serve as a basis for much misunderstanding among buyers and sellers of l.p.g. and natural gasoline because of these limitations.

Natural gasolines and most liquefied petroleum gases are composed of largely paraffin hydrocarbon mixtures in the range C_3 to C_8 or higher for natural gasolines as shown by Boultbee[2], and mixtures of propane and iso- and normal butane for l.p.g. as indicated by N.G.A.A. specifications[3]. Hence volume correction factors standardized by that association have not outlived their usefulness as the correlation given in LC-757 for coefficient of expansion for paraffins with specific gravity indicates (Fig. 2).

On the other hand, refiners may find the Bureau's tables more valuable, for reasons which will be set forth later and also because the products they are selling—such as isobutylene, the butenes and butadiene—do not follow the basis of the tables accepted as standard by the N.G.A.A.

Still another point which may be worthy of further investigation is that the data from which the factors of LC-757 are computed are based on but a single temperature, 60°F. There was no attempt on the Bureau's part to verify the validity of its calculated factors by experimental determinations at temperatures above and below 60°F. The N.G.A.A., however, determined its volume correction factors experimentally, as shown in Carney's[4] report of the association's technical committee in submitting the tables later accepted as standard.

Moreover, it is known that at temperatures other than 60°F. the various hydrocarbons may have widely varying coefficients of expansion and the slopes of such curves as in Fig. 2 may vary appreciably. Thus there is no assurance that mixtures containing very large volumes of unsaturates may not behave differently than either of the two or more materials involved under the same conditions. To this writer's knowledge, there have been no reported experimental investigations on behavior of such mixtures to support the assumptions used in computing the Bureau's factors.

If disputes over the validity of the corrections arise, as some authorities seem to believe will occur, this admittedly expensive experimental work will be necessary to settle the issue. None could justifiably dispute the value of the investigations to the oil industry generally.

For commercial transactions in the natural gasoline and liquefied petroleum gas industry it is doubtful that it will be worthwhile to apply corrections for the vapor left in containers. The value of product left in the container after unloading, compared with the expense of determining the correction, will show so small a difference that savings, if any, will be a minor amount. On the other hand, the "loss" involved with more expensive products, such as butadiene, might render worthwhile the expense of making the correction. An example is the case of butadiene cars where positive pressure is required to avoid contamination with air.

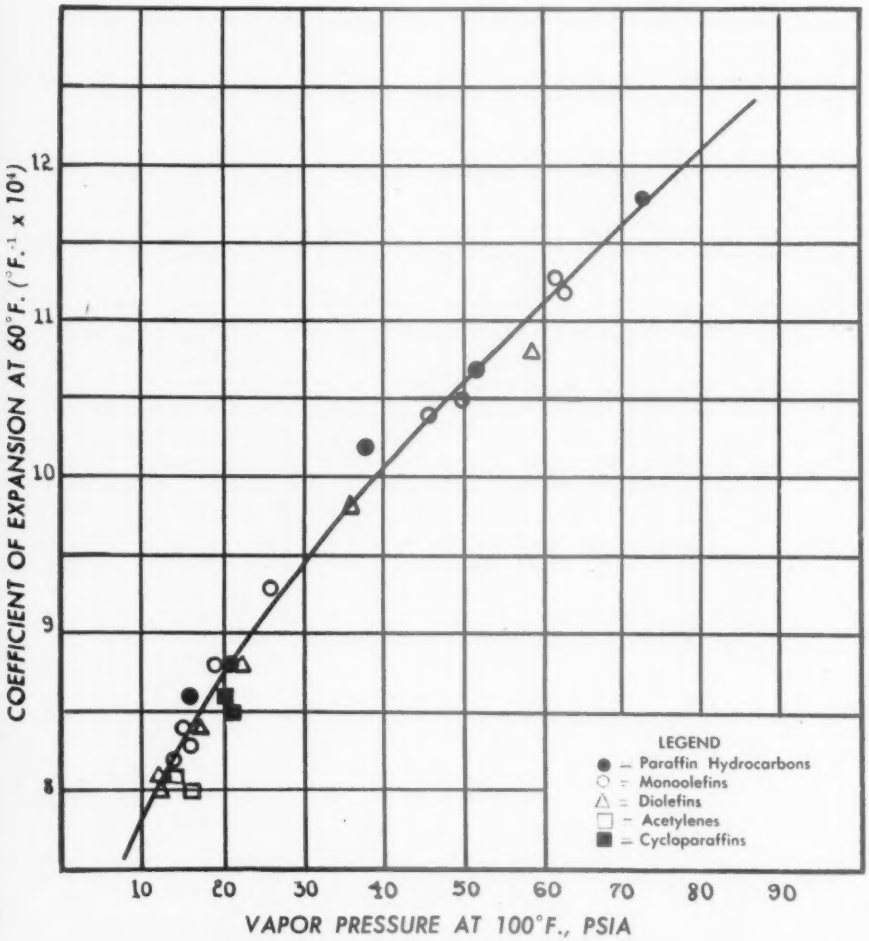

Fig. 2—Correlation of coefficient of expansion at 60°F with vapor pressure at 100°F. Correlation is much closer for all series than the correlation of Fig. 1. This correlation is used as basis for table of liquid volume correction factors in NBS LC-757

Sample Problem Shows Use of Tables

To make this point more apparent, assume a shipment of normal butane is made by tank car to a trackside jobber who has no laboratory facilities for determining vapor pressure; he has a pressure gauge, a thermometer and a pressure hydrometer. Stated water capacity of the car is 10,600 gal. Upon gauging it is found to contain 10,000 gal. at a temperature of 81°F. Pressure on the car is determined as 38.2 psia and the specific gravity 0.570. After emptying by pump, temperature of gas remaining in car is 65°F. and pressure is 28.8 psia. How much *n*-butane shall he pay for at 3c per gal.?

Using the observed pressure of 38.2 psia and the vapor pressure conversion tables of LC-757, vapor pressure at 100°F. is indicated to be 52 psia. Using this value and the observed temperature of 81°F. in the liquid volume conversion factor table, the desired factor is found to be 0.9774—assuming linear extrapolation is permissible between values in adjacent columns for all tables. Then,

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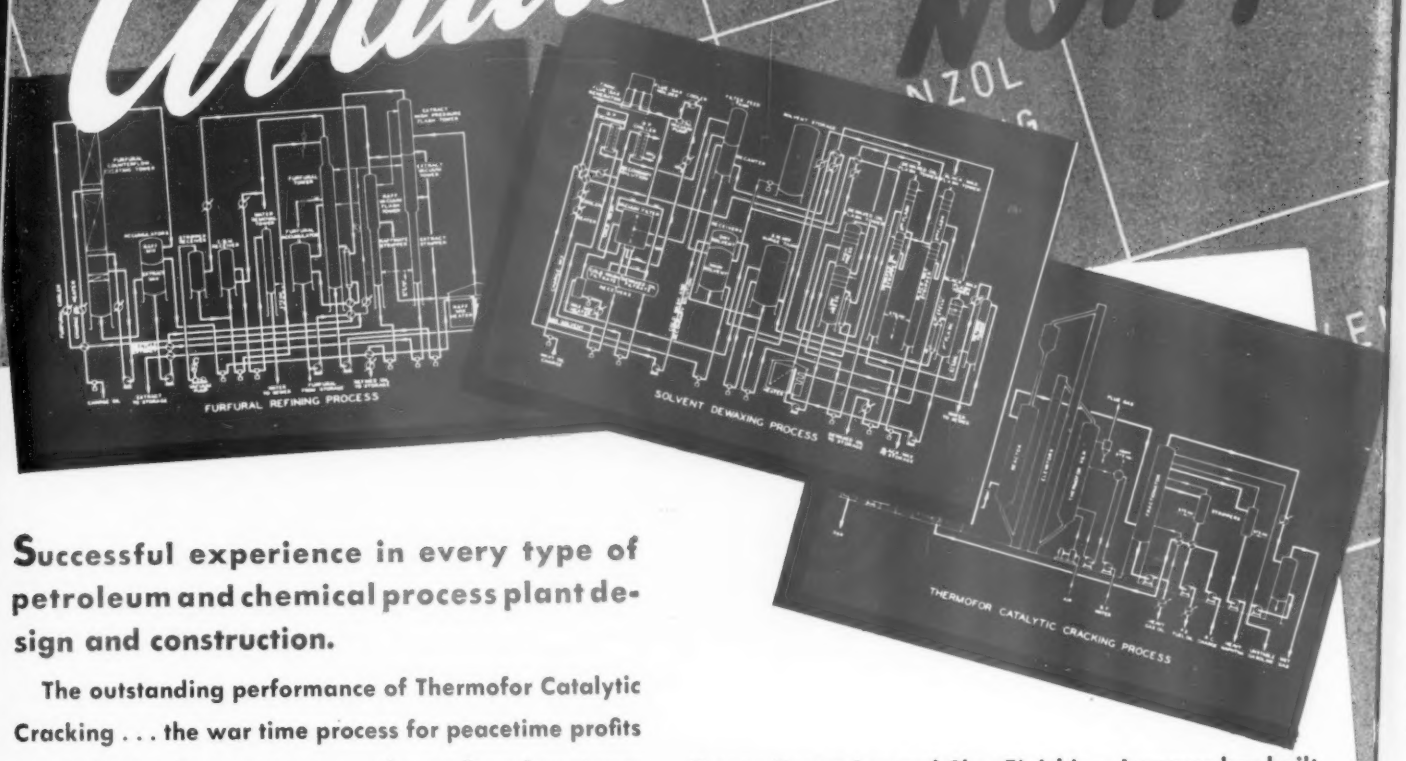

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multiplying gauged volume of liquid, 10,000 gal. by the factor just found, 0.9774, the volume of *n*-butane in car at 60°F. appears as 9774 gal.; this corresponds to an indicated gross value of $293.22 (9774 × $0.03).

It is obvious that the tank still contains some vapor after the liquid has been withdrawn because car temperature is lower and pressure still is above atmospheric. However, this subject has long been settled by the liquefied petroleum gas industry to the extent there is a practical means of removing them if the buyer so wishes.

Many tank cars are unloaded by means of air or gas pressure, wherein the vapors are diluted and therefore are of little or no value. Vapors remaining, diluted or otherwise, are of no value to the shipper since they are vented down to a very low pressure before reloading to avoid loss in loading time and prevent possible popping of relief valves due to slow condensation as the liquid rises in the car.

Calculations will show that with liquefied petroleum gases time required in making measurements and using the tables of LC-757, plus the money involved in amortization and maintenance of the required equipment, will eat up any "saving" resulting from correcting for vapor left in the car.

On the other hand, if the liquid were 1,3-butadiene, which costs perhaps 95c per gal., there might be some justification for the correction, *providing* the same hydrocarbon had been used in pressuring the car, or it was pumped out without pressuring. If nitrogen or natural gas were used for pressuring, the vapors would be contaminated and no correction could be made. An alternative would be to remove the vapors with suitable gas compressors.

N.G.A.A. Tables Less Complicated

As a comparison, assume the same problem but using N.G.A.A. Standard Table[5] for the calculations. Only measurements necessary are volume of liquid in the car (gaging or metering) and the observed liquid temperature and liquid specific gravity at that temperature. Conversion of the observed specific gravity at 81°F., 0.570, to corresponding value at 60°/60°F. by the appropriate table gives 0.584. Using this value and the observed temperature in the table of volume conversion factors indicates the factor to be 0.977. Multiplying the observed volume, 10.000 gal., by 0.977 gives 9770 gal. at 60°F. and represents a value of $293.10. While there is no provision in these tables for vapor volume correction, this could be calculated easily if desired.

Notice that the volume thus determined is lower by only 4 gallons than the corrected volume as determined from tables of LC-757, representing a money value of 12c. Notice also that there was no necessity for investment in facilities either to measure pressure on the car or to experimentally determine vapor pressure of the liquid at 100°F. plus the man-hours required in such determinations and the calculations necessary for the final answer. Actually, the only calculation required using N.G.A.A. tables is the multiplication of observed volume by the correction factor, to determine liquid volume at 60°F.

Upsets Shipping Practice

Thus it would appear that, unless valuable liquids are involved which contain large amounts of unsaturated and cyclic hydrocarbons having 4 carbon atoms, the new volume correction factors presented by LC-757 will not prove of any economic advantage.

There is another disadvantage to the use of the Bureau of Standards Tables. Determination of vapor pressure by any method is subject to greater inherent errors than determination of specific gravity, because the procedure is more complicated. By this is meant the N.G.A.A. standard pressure hydrometer method and not the N.G.A.A. bomb method. Experimental evidence gathered by this association indicates the accuracy of specific gravity measurement by this procedure[6] is sufficient for all normal purposes if reasonable care is taken. Time consumed is only slightly in excess of that required for ordinary specific gravity determinations at atmospheric pressure, and the instrument itself is as rugged as any other hydrometer.

To accurately determine vapor pressure one must have a close approximation to laboratory facilities; some manipulative skill and training on the part of the operator also is required. In event vapor pressure is determined by gauging car pressure, a delicate certified gauge is required to secure any reasonable accuracy. As much or more time will be consumed in installing it, determining the reading and then removing it as will be used in making a specific gravity determination with a pressure hydrometer.

Moreover, by going to vapor pressure the Bureau of Standards' new tables upset current shipping practices. Current Interstate Commerce Commission and Bureau of Explosives regulations on filling densities require determination of specific gravity for the computations involved. National Board of Fire Underwriters, Underwriters Laboratory rules, and many state laws and fire marshal regulations likewise are based on specific gravity, tied as they are to ICC, NBFU and B of E. regulations.

May Cause Disputes

An objection to the Bureau of Standards' tables that may prove serious is the possibility of misunderstanding their applicability by sales departments, or mistakes due to confusion in using two sets of standard tables. Refiners, for example, are receiving shipments of paraffin hydrocarbons from natural gasoline manufacturers—on which the natural gasoline division of the oil industry has used their own standard (N.G.A.A.) volume correction tables—while refiners also are shipping among themselves "B-B" fractions or butylenes and butenes—on which they will endeavor to use the Bureau's tables.

Clerks may "slip" every now and then and forget that the factors of LC-757 do not apply to C_4 hydrocarbon mixtures containing appreciable quantities of C_3 or C_5 and higher hydrocarbons, and thus should not be used in connection with mixtures of propane-butane or for natural gasolines containing appreciable quantities of hydrocarbons with more than four carbon atoms.

A practical answer to those who ask who should pay for the vapor left in the container is for the two parties to agree that payment shall be on basis of liquid metered during withdrawal from the car, with appropriate corrections if ambient temperature departs from the standard 60°F. Still another, which would get away from using tables, would be to mutually agree on some predetermined arbitrary average figure in terms of dollars, gallons or pounds in the event shipper requested return of cars under specific conditions to avoid contamination.

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Correction, Please!

In the story on the Aviation Gasoline Advisory Committee, which appeared in the December 6 issue of NPN's Technical Section, we incorrectly promoted Elliott B. McConnell, who is with Standard Oil Co. (Ohio). He was listed as being Vice President in charge of Manufacturing, instead of Assistant to the Vice President in charge of Manufacturing.

Survey of Past and Present Trends in Lubricating Oil Additives*

*By W. Andrew Wright***

Progress in the development of different classes of additives for lubricating oils is shown as evidenced by the numbers of U. S. patents granted over the past several years. While the lubricants of the future will be improved by advances in refining technique, it is pointed out that much of their improvement will come about through the use of specialized addition agents, in place of general purpose additives. In this connection the need exists for better understanding of the mechanisms involved during the service of a lubricant, in order to permit the design of more efficient additives as well as to improve the qualities of the oil itself.

An appendix (not published here) lists by patent number the U. S. patents granted in various classes of additives.

THERE is no doubt that the majority of those present at this meeting are well acquainted with the use of addition agents in lubricating oils. However, it may be well to define these materials and outline the reason for their use. A lubricating oil additive is a chemical compound not normally present in the refined oil which has the ability to control the course of chemical reactions, or to initiate desirable reactions during the use of the oil. In a broader sense, additives are also used either to give the lubricant certain physical properties not possessed by the oil or to improve upon those already possessed by the oil.

By the use of addition agents, the life of the oil may be greatly extended, as well as the useful life and mechanical condition of the operating equipment. The ability of the lubricants to carry loads many times normal is achieved, and mechanical designs for very severe types of service become less difficult or become more readily attainable.

The use of additives in lubricating oils as a means of improving desirable properties is known to have been practiced even before the era of mineral oil lubricants. The patent literature is typical of the general trends. For the purpose of general discussion, the writer has elected to trace the developments in this field as evidenced within the structure of U. S. patents, and to draw generalized conclusions from this source as well as the known practical application in the lubricating industry.

To all practical purposes, any studies based on the more prominent types may well be considered to yield typical information. Such agents could be listed as: Antioxidants; Oiliness or Extreme Pressure Agents; Pour Point Depressants; Detergents; and Viscosity Controllers.

It has often been stated that advancements based on accumulated knowledge can be expected to be made at an increasing rate. If we take the U. S. patent history over a period of years, as shown in Fig. I, we find that this is apparently not true, and a quite constant rate is present in a plot of patent number versus date. If this is traced backward until well before the last war, very little change in rate is found. It seems significant that any gain in knowledge or solution to a problem still has a strong factor of good hard work in it. Examination in a more detailed manner of more specific types of knowledge do show marked changes in rate. Requirements of the moment are an important factor in such cases.

It was mentioned before that the use of lubricant additives was quite old, but the period between 1930 and 1935 marks the beginning of activity in this field as we know it today. This is shown in Fig. II. There is food for considerable thought in these assembled data. The marked rise in patents for various types of additives is in excellent agreement with actual usage in the industry. A point of particular interest is the presence of prominent maxima and the declines immediately following. There are several possible reasons for this:

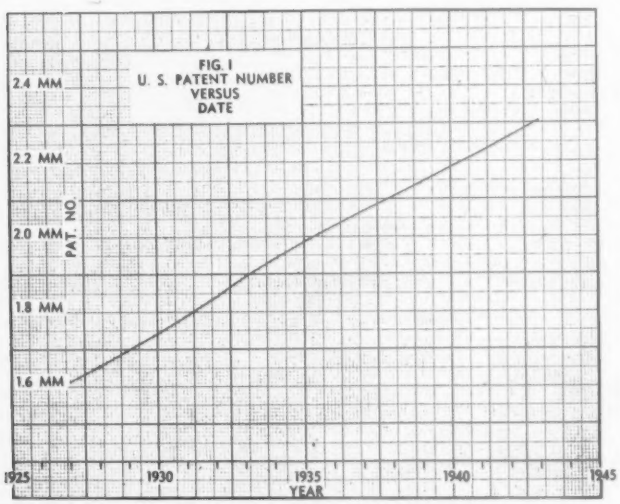
1. Effect of war.
2. Satisfaction as to adequacy of present products.
3. Probability that we have taken almost every possible compound off the shelf and are being hard pressed for more.

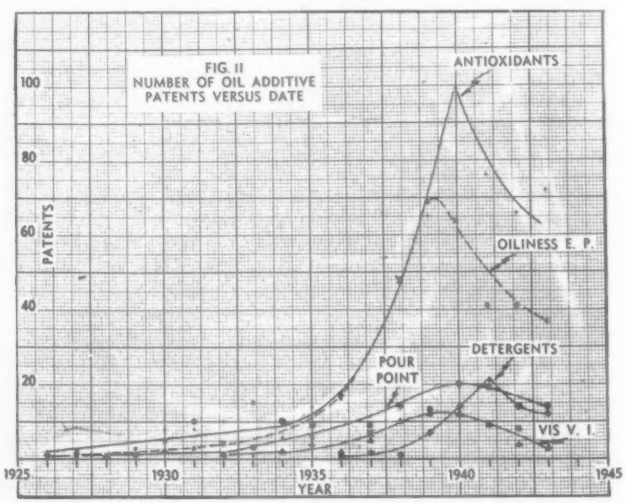
Items 1 and 3 are probably the best explanations, since we are a long way from being fully satisfied. It is interesting to note that the maxima occur in 1939 and 1940 and considering the fact that the patent situation is such that two or three years often elapse between experimental work, application and granting, the advent of war cannot be held mainly responsible. There has been with-holding of patents for security reasons, but they represent, it is felt, a minor proportion of the whole. Subsequent to December 1941, manpower has also been shifted to new problems in some instances. Within the patents here listed, we have a number of excellent additives, many of questionable value, and dozens of rationalized "nuisance patents".

It is interesting to examine a typical additive class in more detail. Fig. III shows the trends found for the various types of antioxidants. For convenience,

*Presented at the National Fuels and Lubricants meeting of the Society of Automotive Engineers, Tulsa, Nov. 9-10, 1944.

**Development Engineer, Sun Oil Co.





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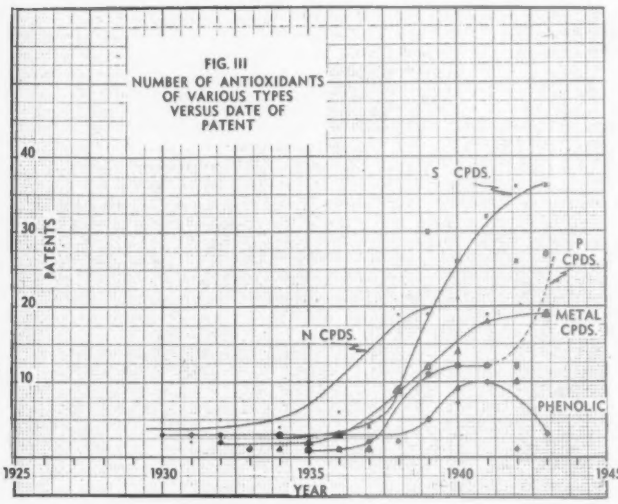

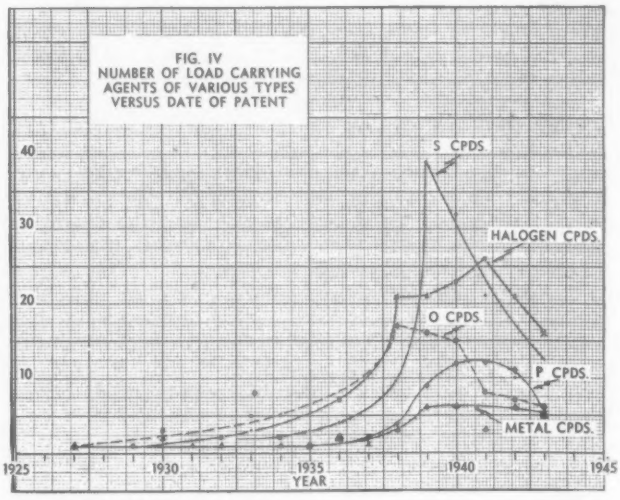

all nitrogen compounds of various types were grouped for purposes of plotting and similarly for the other types shown. There are numerous instances of cross indexing. For example, a compound containing both a sulfide and an amine appears under both types. Amines have probably been known to be antioxidants, in appropriate cases, for the longest period of time. It is logical that they should have been the object of the earlier work, once rapid growth began to appear in the field of antioxidants.

Within a few years other types began to appear. The sulfur compounds became very prominent and it would appear that they have not yet passed their peak. The other types appear to be leveling off or at a point of uncertainty. It is of course, quite possible that a highly successful structure might be developed in any one of these types which will start a wholly new trend. Examination of the literature and patent structure shows that the initial steps were often in terms of the relatively simple typical types of organic compounds. This was followed by a strong trend toward more complicated structures and permutations of the individuals.

The hope that these would prove more general in their applicability has been borne out in a number of instances. Others of a similar nature are evidently attempts to provide a protection against future developments. Another development was the attempt to provide in one complicated compound a wide variety of additive properties in general, such as a compound which would have the ability to act as an antioxidant, load-carrying agent, pour point depressant and viscosity index improver. Compounds having at least a dual character are quite common and have been applied successfully.

Fig. IV is an attempt to trace the trends of typical chemical types of compounds used as agents for improving load-carrying ability. For simplification, a great deal of grouping has been made. For example, the line for metal compounds includes both organo-metallic as well as soaps. For the immediate purpose, it is not felt that the conclusions are invalidated. In the Appendix, the separations have been maintained. Many patents appear under more than one listing due to cross indexing. While the Appendix probably does not contain all patents which have been granted in the field of additives, or even of those classes listed, the coverage is sufficiently complete to feel that an adequate sample is at hand. (The Appendix which lists the patent numbers of the various types of patents is omitted but Table I gives the total number of each group as given in the Appendix.)

The foregoing discussion, together with the actual experience that we have had in the last several years, indicates that we have made excellent progress in the development of lubricants for general and specialized purposes. We find ourselves in a position where we cannot rest on these successes. The goal we have set and the more stringent demands that we must meet in the future indicate that progres from here on will be more difficult and tedious. It is that future, and the methods by which we shall approach it, that I would like to consider.

The development of additives for various purposes is strongly influenced by the method of study and test. Some may contend that the use of full size equipment and the adoption of several standard test procedures, other than bench scale, tends to eliminate questionable results. It is true that the end point evaluations are made in this manner, but such tests are often preceded by many simpler and less expensive operations. It is in these stages that the initial evaluations and modifications are made. Careful work of this nature has resulted in additives which have proved of value when given the more stringent final tests. While improvements may follow after making full scale tests, the fact remains that the pattern was often laid out in the earlier stages. The implication that such a procedure is not satisfactory is not intended. It has many valuable points, but the application of such testing must be conducted with care and experience.

We of the petroleum and related industries have developed or tried dozens or possibly hundreds of such oxidation tests, for example. Most of these have been discarded, often with some reluctance. The odd part of this is that probably all of these were valuable. There still exists in almost everyone's laboratory a "pet" test procedure which is relied upon and is felt too valuable to discard, in spite of the fact that some of the others of us might feel that it gives us little "correlation" with the service that we wish to simulate. The obvious reason for this is the fact that the user has learned to apply complicated correction factors, sometimes subconsciously, to the data the test produces. We have such a test apparatus which we feel has failed us in only one instance, and we allow for the variations when dealing with additives of that particular type.

The continual attempts to produce laboratory test methods which will evaluate an oil for actual service must indicate that there is a conviction that it can be accomplished, in spite of the strong contemporary feeling that it cannot succeed. The writer at one time found it necessary to develop the equations for heat transfer coefficients in a type of heat exchanger that was quite different from those in general use. Fortunately, there was the experience of many experts in this field to lean upon. Through their efforts, the various dimensions involved had been carefully studied and outlined. As a result of this, the experimental data were applied in terms of the proper dimensionless quantities and a very satisfactory equation was achieved.

There is no doubt that if attempts at evaluation had been made by grossly empirical means, which included reckless grouping of divergent factors, we would still be searching for the relationship involved. Unfortunately, the

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latter method is still too much in evidence in the development of lubricants and additives. We rationalize, I am afraid, by pointing out the extreme complexity of the factors involved as a partial excuse for our methods of attack.

Each factor that can be isolated from the rest is that much gained, and makes the separation of the remainder that much easier. We are about to enter a period which will demand the utmost in our efforts, and improvement in method is seriously needed. We have learned by experience that certain types of additives will give desired effects in certain types of lubricating oils, and are often able to give only the most vague explanation for their action. In the lubricating industry, the production of grease has usually been considered to be an art. It has been found, however, that the factors can be evaluated for a grease system with the result that the substitution of values from an ordinary careful analysis in an appropriate equation will permit a very accurate calculation of the various physical properties of the grease.

Our real need is an understanding of the mechanisms involved during the service of a lubricant. This idea is far from original, but is still begging for wholehearted trial. A few workers in the field have recently been experimenting on the fringes of the problem, and their findings look like they might well destroy some overaged hypotheses. Let us indulge in some armchair research—sort of practical pipedream. Selecting oxidation as an example, we can outline the desirable state of stability as follows:

1. Oxidation stability (oxygen consumption)
   - (a) Anti-acid } Anti-corrosion
   - (b) Anti-peroxide }
   - (c) Anti-sludge
   - (d) Anti-resin (acids?)
   - (e) Anti-viscosity increase
2. High Thermal Stability
   - (a) Resistance to cracking at high temperature
   - (b) Low temperature coefficient of oxidation
3. Low Catalytic Susceptibility
   - (a) Fe, Cu, Pb, Ag, Cd
4. High oil solubility for oxidation products

With some slight modifications depending on the particular type of service in mind, the above list represents an ideal general specification. Aside from the helpful effects of any additives, the various items are specifically related to constitution, mechanism and condition of service.

It is quite possible that we have struggled for too many years with the spectre of "correlation" between test procedures and service. The large majority of the "ideal" specifications previously listed can be determined with sufficient directness over an adequate range of temperature and catalytic conditions, to evaluate the individual characteristics. It would seem possible to eat our pie a piece at a time with far less chance of spreading it all over our faces. Careful examination by more simplified stages of study will give us much better knowledge of the mechanisms involved.

The inclusion of additives in the oils under test by stepwise methods will give us information on the mechanism of their operation and permit the design of new and improved forms in a much more reliable manner. These comments seem to have been much more concerned with the base oils than with additives. However, we have all found that the base oil and its source of crude, extent of refinement, constitution etc., are quite significant in selecting an additive for improved results under selected service conditions.

Undoubtedly most of us have tested additives which have proved very helpful in one type of base oil as antioxidants and act as pro-oxidants in another, or the apparently confusing case where we have used copper compounds as a deterioration catalyst while some one else patents such compounds as antioxidants. We have found by laboratory experiments that we are both right. The confusion arises from the fact that we do not know enough about the mechanisms involved.

We need to know the effects of the various typical types of antioxidants when present with oils of the common molecular types, under oxidizing conditions. We need to have more specific information as to the change of activity of these antioxidants with temperature, and if possible, the band of oxidation reactions they control suitably. We do know that they differ in this latter respect. We need to know whether some so-called antioxidants really act as pro-oxidants to hurry the reactions past those phases having undesirable by-products.

Other additive studies, such as the fields of detergency and extreme pressure lubricants, are also in a timely position for more detailed work. The present accepted standards of testing for detergency in heavy-duty oils are a step in the direction of specific determinations, to the relative exclusion of other features of the lubricant. Much remains to be done in clarifying the distinction between detergents and dispersants. Some information is becoming available on the types of detergents most likely to be satisfactory in the various types of base oils, but the day is bound to come when we will be able to prescribe with good assurance for the needs of a particular oil. So-called "oiliness" agents and extreme pressure additives still need to be studied and classified as to mechanism of action for various surfaces and evaluated in terms of activity over wide temperature ranges.

It might well be said that the test methods implied are idealistic and far too time consuming. It might be true that they err in that direction, but much can be gained by their use. There should be but little in the way of lost time since the basic information would permit more rapid progress. Our present extensive practical knowledge of the effects of various additives would become correlated to a much more useful extent. Examination of the patent literature in the field of additives shows great spurts of activity in each zone of requirement and general chemical type. It seems quite evident that in a surprisingly large portion of this, no effort has been spared to place every type and modification of chemical compound in the record, just in case—. We are fast approaching the point where rule of thumb, and cut and try, will fail to yield the advances required.

The lubricants of the years ahead will be carefully formulated and highly specialized. While undoubtedly there will still be important techniques developed in the field of refining, much of the load will be borne by specialized addition agents. Those which we now rely upon as highly effective will be improved greatly. This will be the result of research whose methods will be vastly improved, if not distinctly changed. The ability to "prescribe" additives for a lubricant will undoubtedly be achieved. Those manufacturers of lubricant additives who first offer the necessary information on their products will be doing a real service and will enjoy an enviable position in the field.

TABLE 1

Number of U. S. Patents on Lubricating Oil Additives, by Type:*

Type	Number
Antioxidants	662
Amines	67
Misc. Nitrogen	86
Phenols	48
Sulfides	53
Hydroxy Sulfides	13
Misc. Sulfur Compounds	129
Phosphorous Compounds	96
Organo-Metallic and other Metallic Compounds	106
Misc. Agents	64
Oiliness or E. P. Agents	522
Sulfur Compounds	142
Halogen Compounds	146
Phosphorous Compounds	56
Oxygen Compounds	102
Metal Compounds	37
Misc. Agents	39
Detergents and Dispersants	95
Organo-Metallic and other Metal Compounds	55
Metal Phenolates	10
Acids and Esters	12
Condensation Products	7
Miscellaneous	11
Pour Point Depressants	174
Hydrocarbons	40
Halogen Compounds	17
Oxygen Compounds	66
Nitrogen Compounds	4
Metal Compounds	29
Miscellaneous	18

*Data from the Appendix to the paper "Survey of Past and Present Trends in Lubricating Oil Additives."

Inspection of Piping Systems

By Arthur C. Barton and Wes Miller

THE designer of a piping system for the modern refinery strives to arrive at a fluid conveyor system which will permit transportation from point to point in the least possible time, with the lowest expenditure of initial investment possible with sound practice and with the fewest bottlenecks and traffic jams.

He also bears in mind that once this system of fluid highways is erected, it must be capable of being maintained in a state of high effectiveness at a minimum of cost for maintenance and alteration and repair. Meeting these conditions is not the easy task which a recital of the objectives might infer. However, there is adequate evidence that the piping designers are more and more aware of the importance of their work and on the alert to evolve more efficient designs.

In the operation of the modern plant piping system the inspection department can play a broader and more important role than is many times assigned to it, and it is the purpose of this article to describe the general functions of this important branch or division of the plant operating force.

The normal course of affairs preceding the inspector's first knowledge of the job has probably been somewhat on this order:

(1) Layout—arrangement and location of the pipe lines and piping system elements.

(2) Design—proportioning of lines, types of joints, supports, anchorages, drainage, provision for expansion, materials of construction, etc.

(3) Drawings, specifications, bills of materials, etc.

Thus, the inspector ultimately finds himself armed with a mass of data and is ready to ponder the question of what he is to do with it. This, then, is probably as good a place as any to discuss the question, "What is inspection?"

In most engineering and construction organizations, inspection has been accorded the primary function of being merely a means of securing a complete job in strict accordance with predetermined designs and specifications. A few organizations have progressed to the point where inspection has been used to secure compliance with preconceived ideas, and as a source for obtaining operating performance data on the functioning of completed units. The modern broad viewpoint requires that inspection should also be used to obtain these several other desirable objectives:

(a) Inspection should be a connecting link between design and fabrication to the extent that desirable new designs should stimulate the shop to improved fabricating methods and that improved shop practices should be reflected in engineering department designs.

(b) Inspection should serve as liaison between the engineering department and the field in interpreting the intent and purpose of certain engineering department policies and construction; to convey to the engineering department the benefit of improved methods and constructions developed by the shop and field men, and their supervisors; and to devise ways and means of incorporating such desirable new methods into current engineering department designs.

(c) The inspection division of the engineering department should serve in a functional capacity in assisting and advising the shop and field on setting up adequate inspection schedules and effective forms of inspection for given purposes; and in providing specialized help in the way of welding procedures, welding specifications, and tests for welding operators.

The accompanying article on the inspection of piping systems is the result of many years of research and experience by the authors in the general fields of inspection and mechanical engineering.

Arthur C. Barton has been active for over 16 years in the design and construction of chemical plants, including in recent years high octane aviation gasoline and synthetic rubber plants. He has developed improvements for horizontal storage tanks and has written and conducted a course in unfired pressure vessels for Pennsylvania State College Extension Service. At present he is associated with the H. K. Ferguson Co.

Wes Miller was resident inspector for 15 years with the Hartford Steam Boiler Insurance and Inspection Co., and more recently has been Chief Inspector for the Blaw Knox Division of Blaw Knox Co. on synthetic rubber plants.

(d) Inspection service should be scheduled so that various points are visited periodically and regularly during the course of fabrication and erection so that possible errors may receive correction before trouble becomes difficult to rectify; so that progress information may be available promptly to various interested sources; and so that desirable changes may be placed before the engineering department for early consideration and action.

(e) Inspection should serve as a means of contact with a completed job by regular and sufficiently frequent visits during the operating life of the equipment to secure information regarding rates of deterioration of plates, piping, fittings, etc.; and service performance of instruments, pumps, compressors and other mechanical equipment, so that sound data may be available for use in future designs.

(f) Inspection should serve as a means in helping to intelligently standardize design, practice, equipment, erection methods, and the choice of erection processes. It should also serve to integrate tolerances specified for related apparatus.

(g) Inspection should serve as a help in training designers by correlating the application of theory to the actuality of a finished project.

(h) Inspection should serve as a source of quality control of a finished product.

(i) The inspection department should make and maintain contact with the state and other legal authorities concerned with the enactment and enforcement of codes. Through such contact, proposed changes of statutes which will affect an industry's welfare may be either nullified, modified, or pushed to enactment. Thus, early notice of changes in legal requirements is obtained for guidance in design and construction. Such contacts are also valuable in many instances in securing waivers of compliance with technical violations either before or even after such violations are an accomplished fact.

(j) The inspection department should carry on some research within its parent organization and associate with recognized engineering organizations and research bodies outside the parent organization to keep abreast of developments.

In discussing some details of inspection work it is perhaps an advantage to follow some logical order. Since piping systems usually go in successive steps from materials, to fabrication, erection, operation, and maintenance, inspection will be discussed in this sequence order.

Before any fabrication is started, the material of the pipe fittings, valves, bolts, nuts, flanges, etc. should be determined as to physical and chemical properties. This is done either by careful examination of mill test reports when they are available, or by removal of pieces for laboratory determination of the physical and chemical properties of the material. Much depends on this checking of the materials of construction because the ability of the material to withstand pressure, temperature, resistance to erosion, corrosion, and design stresses are functions of its chemical and physical properties. When welding is used as a method of joining, the quality of the joint can be greatly influenced by deviations from prescribed chemical and physical properties of the material. Measurements should be made to ascertain the thickness of pipe walls, valve bodies, and fittings for compliance with specifications. Accessible surfaces should be examined for scars, general finish, laminations, blowholes, evidence of core shifting, and condition of threads. Flanges should be

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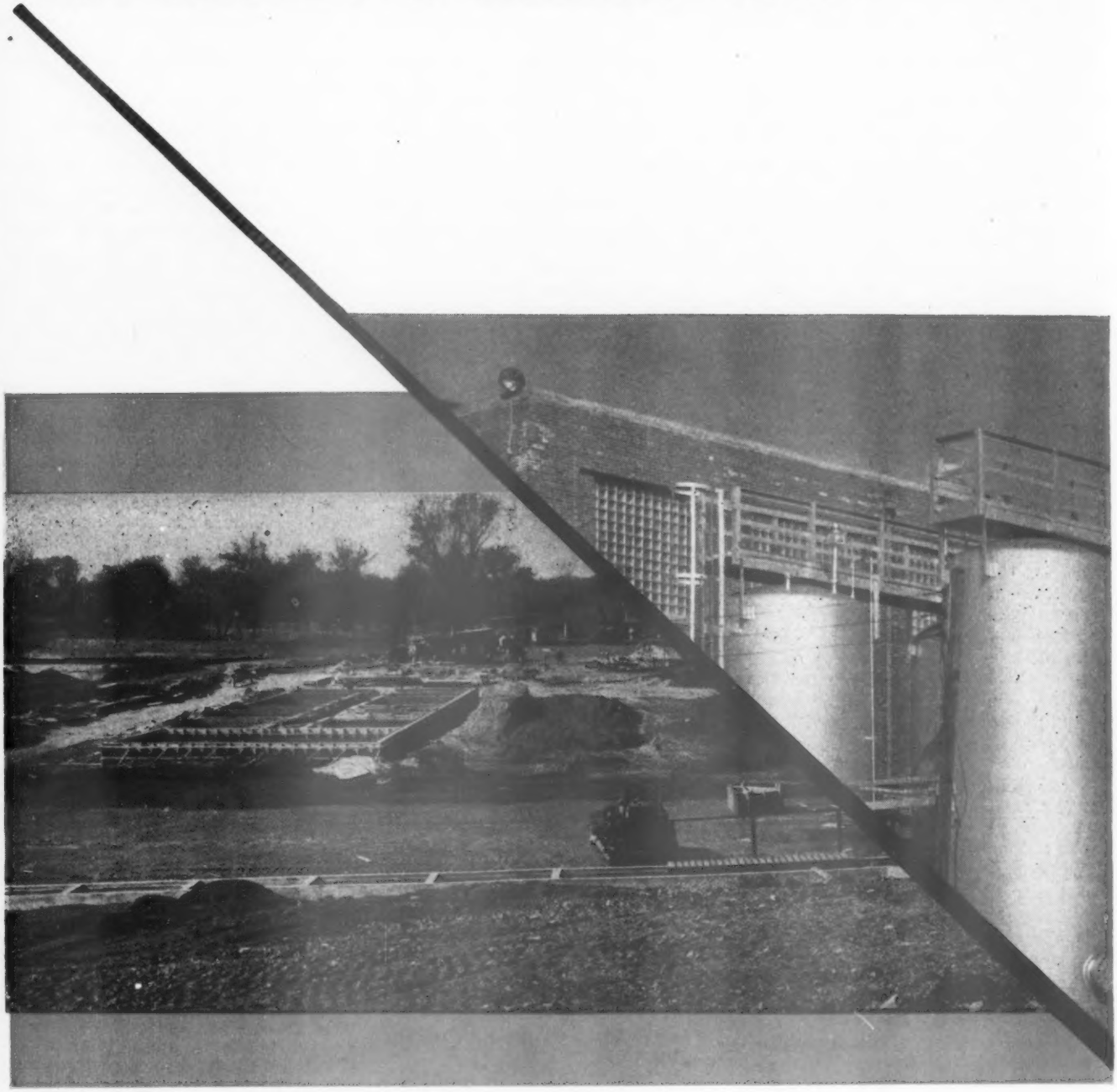

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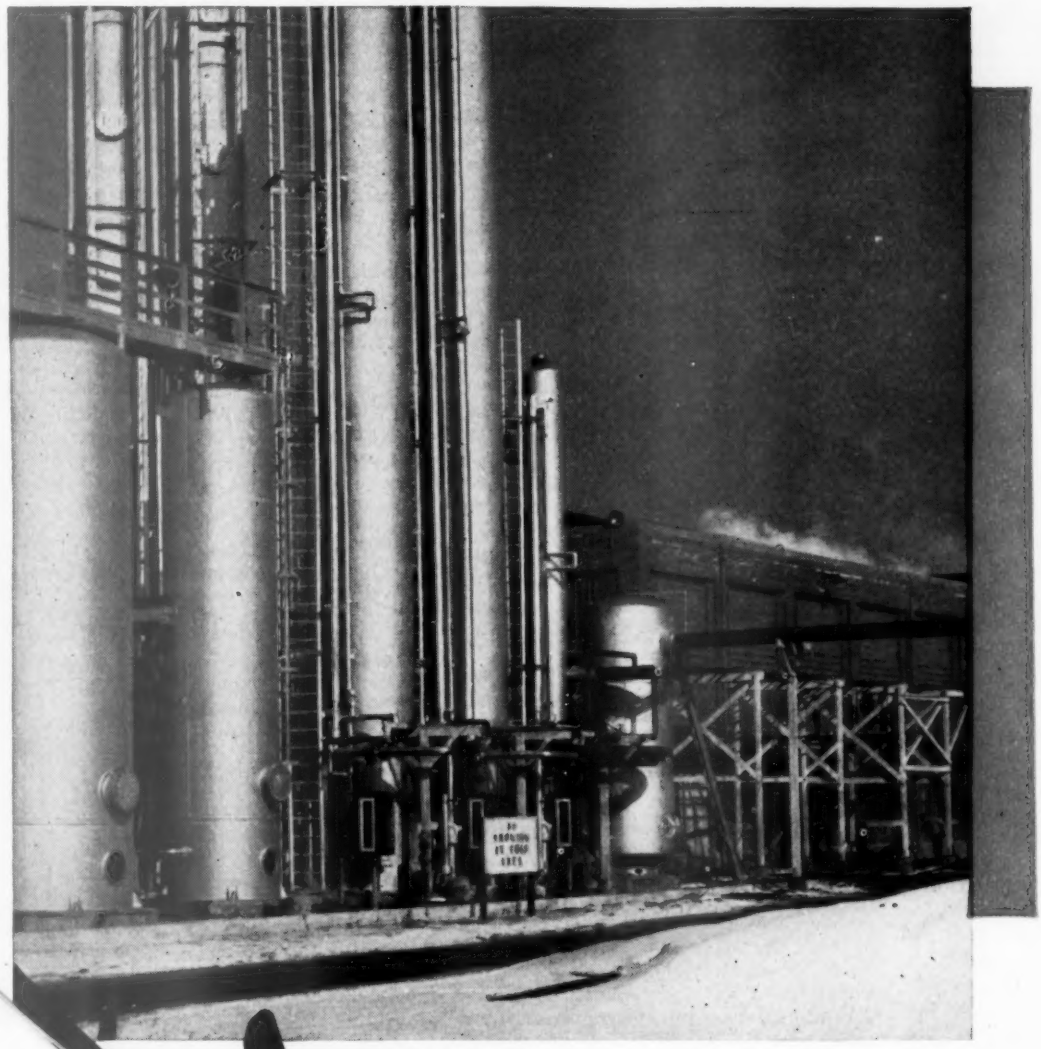

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For welded construction, a determination should be made of the existence of a recorded welding procedure, including a qualification test to cover the materials to be welded, the positions in which welding will be done, and the types of joints to be used. This welding procedure should then be adhered to.

As fabrication gets under way, the piping should be examined as it is cut and fitted. Root spacing and root faces should come within the specified limits. Backing rings, when used, should fit snugly. Reinforcing plates for branch connections should be properly fitted and drilled with small vent holes. The amount, distribution, and attachment of the reinforcement should be noted to see that the quantity of reinforcement is ample, that this quantity is disposed about the opening to be reinforced at the point where it is most needed, and, finally, that the attachment of the reinforcing is at least as strong as the amount of reinforcement applied.

Dimensional checks should be made from time to time as assembly progresses. Nozzle flanges should be checked for squareness, alignment of bolt holes with mating pieces, and trueness of flange faces.

Tack Weld Terminal Flanges

Whenever possible, it is advisable to merely tack weld terminal flanges in place. This permits proper fitting of mating faces before final welds are made. Also, it often saves considerable expense in fabrication where tolerances on the order of 1/32-in. variation may be given in an overall length of 20 ft. If the mating terminal flange is only tacked in place it can be shifted a small amount to care for the actual final fit-up of the pipe line. The final welds can then be made after mating flanges are bolted.

Where pipe flanges are to match up with nozzle connections on glass-lined pressure vessels it is particularly important to bear in mind that the glass-lining operation requires the vessels to be heated to a comparatively high temperature for successful application of the glass. It is not uncommon to get considerable distortion of the vessel nozzle connections and this distortion cannot be corrected after the lining operation without destroying the lining. Hence, piping with flanges precisely attached will be fine examples of good workmanship but may be a source of expense in more ways than one in completing the job.

As each sub-assembly of the piping is finished it should be subjected to a hydrostatic test and carefully examined for leakage and signs of distress while under the test pressure. For welded assemblies, the hydrostatic test should be supplemented by a hammer test of the welded joints.

Whenever feasible, for protection of life and property, water should be used for the initial testing of a piping system or any of its component parts. Care should be exercised to see that all air or gas has been removed from the interior of a piping system before applying the liquid pressure.

If oil (or other liquid) is to be used as the pressure-exerting medium for testing, a preliminary survey should be made regarding the potentialities of consequent fire and injury to life and property should failure occur under the test pressure.

When air (or other gas) is to be used for pneumatic-pressure tests, similar care should be exercised. Whenever possible, pneumatic-pressure tests should be made with suitable inert gases. If more than one kind of such inert gas is available, that gas having the least internal energy (under the pressure and temperature test conditions) should be employed. In none but the very exceptional case should highly toxic or lethal gases be used for pneumatic-pressure tests. It is not desirable to apply a hammer or shock test to piping under pneumatic pressure.

There are certain cases where the use of generally accepted test pressure values may result in stresses exceeding the elastic limit of the material. Such instances might arise in connection with correcting test pressures at ambient air temperature to simulate stress values at design pressure and elevated temperature, or design pressure and sub-zero temperature. In accordance with good engineering practice, the test pressure in any particular case should be adjusted so as to not exceed the elastic limit of the material.

Upon completion of any pressure test, all lines should be cleared of the test fluid. This is particularly important when tests are made with liquids at temperatures where either freezing or heating may cause extremely high pressures capable of bursting valves, fittings, and other piping system elements. Special care is required to see that trapped liquid is removed from the space made by double valving.

Globe valves should not be subjected to an unbalanced test pressure under the seat greater than one and one-half times the primary service rating. A greater pressure may be applied above the seat or with the valve open. It should be borne in mind that under certain conditions a globe valve may inadvertently act as a check valve. For example, a globe valve may be installed with the pump pressure on the top-side of the globe valve disc. If the disc should become disengaged from the spindle, raising the spindle would not raise the disc and, hence, fluid would not flow thru the valve.

For this reason, it is usually good practice to install the globe valve in the feed line to a boiler so that the pressure is under the valve disc. In other instances concerning installation, placing the pressure under the disc may permit repacking the valve gland without isolating the line element from the system. Items such as these are properly considered within the scope of things to be checked by the inspector.

When fluid-pressure tests are made under atmospheric air conditions near freezing temperatures or high summer heat, care must be used in readjusting the pressure of valve discs on their seats upon completion of the tests. This is to prevent the ruining of valves by cutting of valve seats or discs, warping of valve bodies, stripping of spindle threads, etc. due to stresses set up by differential cooling or heating of valve bodies and their internal working parts.

The application of fluid pressure should be under proper control so that the required test pressure should not be exceeded by more than 5% at any time.

No welding or mechanical work should be done on a pipe line while under test pressure.

Pressure gauges should be tested periodically for correctness and test pressures should be corrected for static head when necessary.

When the tests are concluded, the lines should be cleared and turbined, sand-blasted, or cleaned otherwise to remove loose mill scale, weld spatter, dirt, grease, etc. Machined surfaces should be provided with easily removed protective coatings to inhibit corrosive action. Suitable covers should be applied to prevent mechanical injury to these machined surfaces and to keep out dirt and foreign matter. The piping system elements should then be properly loaded for conveyance to the place where erection is made.

Inspector Prepares Data Sheet

At this point, the inspector should prepare a data sheet detailing the materials and pertinent dimensional data to properly describe the piping system element. The extent of the data to be recorded will depend on the use to be made of the record. In general, it can be said that this data is a bench mark to be used during the useful life of the piping to establish such things as rate of deterioration, probable time of renewal of the line, frequency of periodical inspection, suitability of the materials of construction for the service conditions, design data for future use, devising methods of inspection best adapted for detecting accident-producing causes and ways and means of preventing such accidents.

The next step is the assembly of the piping elements into a piping system. Joining of the pipe, valves, fittings, etc. should be done with the same general principles in mind which were discussed in connection with the shop fabrication. If certain points are minimum requirements for securing good work in the shop, then those points should not be waived in the field work. However, it is generally conceded that the details by which the results are accomplished in the field must somewhat vary from the shop detail procedure.

In the field, the inspector will use those guides he followed in the shop but

in addition he must give attention to hangers, supports, anchors, vibration dampening, drains, drips, traps, flexibility, provision for expansion, pipe insulation, and insulation covering and coating.

In general, pipe supports should be of a type to permit adjustment so that piping may be pitched as needed and yet have each support carry its proportionate share of the load while allowing free movement of the piping. These supports should be large enough to support the load and have excess for such items as corrosion-reduction during their useful life, possible exposure to high temperature, and possible extra loads which may be transferred from one support to another. It should be obvious that a properly designed support deserves attachment to some structural member that is at least equal in every consideration to that given weight in proportioning and designing the piping support.

Anchors or restraints must be of suitable forms, proportions, and points of attachment to definitely hold certain portions of the piping in a relatively fixed position to make expansion take place as predetermined.

Drains, drips, and traps must be provided at strategic points. These should be installed to provide ample facilities for placing the line in service as well as for normal operation. On the provisions made in this direction will depend much of the freedom from damage due to water hammer, etc.

Valves Are Important

Reducing and relief valves with their by-passes and strainers need careful consideration. Normally, the reducing valve is the element in this combination which will require the major part of the maintenance. The low-pressure side of the reducing valve should be fitted with a safety valve and a pressure gage. The by-pass should be installed so that the safety valve is always between the source of high-pressure and the line or vessel it protects from excess pressure. Equally important is the fact that the safety valve must be of ample relieving capacity to discharge the maximum quantity of fluid passed by either the reducing valve or the by-pass.

Where a throttling valve is used, and the requirements vary from practically no flow to full flow, it is highly desirable to use a valve with a by-pass as an integral part. The by-pass should be used to control the low-flow requirements and the main valve can care for the medium and high-flow requirements. In actual practice, much of the difficulty experienced with valve chatter and its attendant troubles can be laid directly to using a valve without a by-pass for handling high variation flow.

After completion of the erection work, the piping system should be tested following substantially the procedure previously described for shop fabricated pipe. The piping system is then ready for acceptance or rejection according to previously made agreements. For our purpose, at this time, we shall assume acceptability of the piping and that it is then placed in service.

The piping system should then be inspected periodically and regularly during its operating life. The frequency of the inspections will depend on available operating data. Assuming that adequate data is not available, the inspectors can take the original construction data and set up an arbitrary inspection interval. This interval should be chosen to have a frequency greater than is probably necessary—at least for the first year or two.

The inspector assigned to the work is given the original construction data for the piping system. At the predetermined intervals, he examines the system and makes a record of conditions as found. These conditions are revealed by the use of pressure tests, visual inspection, general examination, hammer test, drilling and calipering, the use of tell-tale holes, magnetic testing, trepanning, and even X-ray or gamma-ray pictures. These findings are then recorded at the time of each inspection as supplementary data to the original data.

A study of this comparative data then serves in establishing accurate time intervals between inspections of the whole piping system as well as any of its elements. The information is very helpful in anticipating renewals and replacements in preparing the budget for expenditures. It is also to be used as a basis for establishing revised operating pressures and condemning thicknesses. It furnishes a way to care for valve and fitting degradation—worn valves and fittings being assigned a series rating comparable to their thicknesses and welding on new rating tags to show the present safe operating pressures.

NEW BOOKS FOR THE REFINER

Principles of Automatic Control Explained

Automatic Control Engineering, by Ed Sinclair Smith presents a fundamental approach to the subjects of metering and automatic control mechanisms. The foreword states this is the first book on control engineering proper to be published in the English language. The author's purpose has been to "provide the reader with tools designed to aid him in solving problems in automatic regulation wherever they may occur."

The first four chapters (56 pages) employ a qualitative, non-mathematical approach to the subject, including explanations of the art of control and terminology used, as well as chapters on "Descriptive Treatment of Control" and "Application of Regulators to Plants." The remaining three chapters take up 102 pages and deal with a quantitative treatment of control.

Because of the intricacy of the mathematics involved, fully half of the text is devoted to appendices. Included in this section are commonly used tables, a review of the fundamental physics required, the mathematics of physical transients, analytical methods for the solution of differential equations, and a selected list of references and bibliography.

Mr. Smith, the author, has had more than 20 years' experience in development, design and patent work in the fields of fluid metering and automatic control. He has been active in the A.S.M.E. Division on Industrial Instruments and Regulators, and in the spring of 1942 conducted a Government E.S.M.W.T. course in control engineering. At present he is engaged in control engineering work at the Eclipse Pioneer Division of Bendix Aviation Corp., and was formerly Engineer in Charge of Patents for C. J. Tagliabue Mfg. Co.

Copies of *Automatic Control Engineering* (367 pages, 5½ x 8½ in., stiff cloth binding) can be obtained through the Book Department of National Petroleum News, 1213 West Third St., Cleveland 13, for $4.00, postpaid.

Machinery for Chemical Processing Described

With the petro-chemical industry coming more and more into prominence and refining itself demanding more exacting operations, refinery process and equipment engineers must give increasing attention to the new and varied types of machinery and apparatus they find it necessary to employ. A recently published book, *Chemical Machinery*, by E. Raymond Riegel, should prove of value and interest to them in this connection.

The text is a collection of exact and useful information relating to apparatus and devices used in various chemical industries. The treatment is primarily descriptive, and the text material is liberally supplemented with drawings and photographs, containing over 400 illustrations.

In general, only those devices which have wide application and serve a number of diverse chemical processes are discussed, with highly specialized equipment being included only occasionally.

The author is Professor of Industrial Chemistry at the University of Buffalo, and perhaps more widely known for his text *Industrial Chemistry*, first published in 1928 and now in its fourth edition.

Copies of *Chemical Machinery* (583 pages, 6 x 9 in., stiff cloth binding) can be obtained from the Book Department of National Petroleum News, 1213 West Third St., Cleveland 13, for $5.00.

Keeping Up With the News

By N.P.N. Special Writer

This series is designed to present a brief, technical-economic summary of some of the many developments in scientific and industrial circles which may relate to the future of the petroleum industry.

The current article contains discussions on toluene by hydroforming, propane and ethane, postwar automobiles, petroleum butadiene, aeronautical gas turbines, and Synthine production. No continuity is intended, save for the idea that all these subjects are linked in some manner to petroleum operations.

The author of this series is a chemical engineer in the research subsidiary of one of the larger oil companies. His duties include a continuous survey of the current technical journals in the many fields now related to the petroleum industry.

Propane and Ethane

It has not been many years since all hydrocarbons below C_5 were considered as necessary evils by the petroleum refiners producing them. Certain amounts of the C_4's, it is true, were necessary for gasoline volatility, but the total available far exceeded the permissible amount, and as for C_3's and below—well, few producers of stabilized gasolines gave them any consideration other than as fuel gases for refinery use.

It is needless to retrace the history of the C_4 fraction in the past few years—hydrocodimers, alkylates, and butadiene speak for themselves, not to mention the demand for such specific C_4 hydrocarbons as isobutane, which has brought more than 30 normal butane isomerization plants into being. Neither is it necessary to describe the growth of premium-utility fuel uses for the butanes, butane-propane mixtures, and (to a somewhat lesser extent) propane itself—the "liquefied petroleum gases" which increased annually in industrial and household use until war demands and critical material shortages became temporary deterrents to rate of growth.

Production, because of these war demands, has continued to increase, some 4,050,000 barrels of isobutane and 19,650,000 barrels of other liquefied petroleum gases being produced in 1943 at natural gasoline and recycle plants, while 4,060,000 barrels of similar "refinery gases" were recovered at refineries. Production in 1944, of course, was considerably higher, many new natural gasoline and recycle condensate plants having been completed during the year.

During the past few years, also, the petroleum industry has begun to take notice of the activity of several important chemical companies—such as Carbide and Carbon, Dow, and Monsanto—which have been increasing their consumption of even lighter petroleum gases for use in chemical manufacture. Some of the petroleum companies themselves had for some time been engaged in similar operations—notably Shell and Standard of New Jersey, and the diversity of chemicals produced began to transform mere interest into actual research and production activity in other and previously-quiescent companies.

Evidence that this interest is continuing is contained in a recent speech made to the California Natural Gasoline Association by C. E. Webber, chief of the natural gasoline section of PAW. Webber revealed that in one month alone, in late 1944, PAW had authorized three projects for the installation of ethane-propane fractionating towers at recycling plants in order to supply some of the major chemical plants making such products as acetaldehyde, alcohols, glycols, carbon tetrachloride, and perchloroethylene. In addition, at least four major chemical and plastics manufacturers made inquiries of PAW as to further supplies of ethane-propane mixtures during the same period, and Webber believes that the trend indicated will provide one of the most promising postwar outlets for the natural gasoline and recycling industry.

Another indication of continued interest is a recently-approved project of the Dow Chemical Co., which plans to construct a 79-mile long, 4-inch pipe line from a plant of the Humble Oil and Refining Co. in the Katy field (near Houston, Texas) to its chemical plant at Freeport, Texas. The Humble plant is said to be producing isobutane, yielding as by-product the liquefied petroleum gases required by Dow for chemical manufacture. The daily capacity of the pipe line will be some 2,500 barrels of butane-propane-ethane mixture. The $842,200 project, which will include new metering and filtering facilities at Katy and a high-pressure storage plant at Freeport, should be completed early in 1945.

The lower paraffins, for a long time, were considered too chemically inert for synthesis. Modern catalytic and high-pressure techniques of pyrolysis, nitration, chlorination, and the like have dispelled this theory in all but a few outdated chemical texts. Some of the products so produced have recently been discussed in some detail;[1] countless others may be expected. Cracked refinery gases have long since proved insufficient to meet all the needs of the growing petroleum chemical industry, and it appears likely that Webber's optimism as to the future use of ethane and propane is well founded.

Toluene by Hydroforming

There are few more spectacular war projects of the petroleum industry than the program for the production of toluene. Without it, it appears certain that the war effort might have been endangered, for how could this modern war have been fought with the some 30,000,000 gals. of toluene produced each year as the maximum effort of the coal carbonization industry? It was said in the early days of the war that at least several times this amount would be required, and, although censorship has forbidden the use of statistics, the fact that some petroleum companies producing toluene were requested in mid-1943 to divert their plants to the production of similar aviation gasoline components speaks volumes in itself. The prolongation of the European war may have caused a further reshuffling of production, but the plants were there, ready to resume toluene production as required.

One of the chief processes which has made possible this record of achievement of the petroleum industry is hydroforming. Comparatively little has been revealed concerning this process, except for data contained in occasional patents, for its commercial development coincided with the early years of the war. For this reason, the appearance of a recent article[2] describing the principles of toluene production by this method and showing a flow diagram of the essential elements of the hydroform-

[1] Wakeman, R. L., and Weil, B. H., *ABC of Chemical Derivatives from Petroleum*, National Petroleum Publishing Company (Cleveland, Ohio), 1943.

[2] Fischer, H. G. M., and Welty, A. B., Jr., *Chemical & Metallurgical Engineering* 51, No. 8, 92 (1944), "Synthetic Toluol from Petroleum by Hydroforming Process."

IF you are a refiner, three cents, the charge for cracking a barrel of oil by the U. O. P. thermal process, will give you the benefit of all the experience, techniques, ingenuity and skill that cost millions of dollars and a quarter century of research and development by a closely-knit organization of trained specialists.

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ing process is of interest in that it clarifies numerous technical points.

Hydroforming, in essence, involves the catalytic dehydrogenation of naphthenic stocks in the presence of hydrogen. The latter serves to hydrogenate olefins contained in the charge stock or produced during the reactions, thus minimizing their polymerization and subsequent coking on the catalyst surfaces. In this respect the presence of hydrogen accomplishes the same purpose that it does in the normal destructive and saturative hydrogenation processes; that is, it lengthens catalyst life through prevention or diminution of coke deposits and makes it possible to have longer runs before regeneration is required. Hydroforming, however, being a dehydrogenation reaction, would not give commercial yields under the high hydrogen partial pressures required to prevent carbon deposition completely, but "by recirculating hydrogen-rich product gas to the catalyst chamber and operating at moderate pressure on selected feed stocks, the formation of coke on the catalyst was drastically reduced, and the catalyst remained active for a relatively long period of time."

It should be noted that another distinction between hydroforming and hydrogenation processes is that the former require no outside hydrogen. Since this greatly lowers the required plant investment, it is little wonder that there was considerable discussion in 1938-1940 among members of the then-existent Hydro Patents Co. as to whether this "intermediate zone" process was inside or outside the scope of their agreement.[3]

For toluene production by this process, stocks rich in methyl-cyclohexane (MCH) are preferred; this compound can be converted to toluene in yields of 85% by weight. Normal heptane, under the conditions employed, yields only 16% of toluene, although 79% of the heptane disappears. Other catalysts and operating conditions can give more favorable toluene yields from normal heptane, but "no process has come to light to make this operation commercially attractive."

Table I presents the toluene and MCH contents of representative American crudes. As can be seen, the MCH content almost invariably exceeds the toluene content, hence such processes as hydroforming make it possible to more than double the toluene yields obtainable. Toluene itself is stable under the reaction conditions, hence need not be separated prior to hydroforming.

Commercial naphthas used in the hydroforming process, of course, are not composed exclusively of MCH and toluene, and the normal hexane, ethylcyclopentane, and other close-boiling hydrocarbons greatly lessen the toluene yields obtained. Since nitration-grade toluene must be of 99+% purity, this means that the toluene produced by hydroforming must be separated from other hydrocarbons in the product. A new extraction technique based on "an old process" is said to have been developed.

TABLE I

Toluene and Methylcyclohexane (MCH) Contents of Representative American Crudes*
(Volume Per Cent)

Crude	Toluene	MCH†
Texas Coastal	0.03	1.2
Conroe	2.0	2.5
East Texas	0.40	1.7
Kettleman Hills	0.70	2.1
Midway Light	0.02	0.52
North Sweden Mixture	0.80	3.7
Panhandle	0.22	2.3
Pecos	0.03	1.0
Refugio	0.26	2.9
Salt Flat-Regan	0.19	1.5
Santa Maria	0.14	0.79
Sugarland	Nil	1.0
Tomball Mixture	1.1	2.1
Tinsley	0.08	0.65
West Texas	0.50	1.3

*Fischer, H. G. M., and Welty, A. B., Jr., *Chemical & Metallurgical Engineering* 51, No. 8, 93 (1944).

†Includes such ethylcyclopentane as is present.

Postwar Automobiles

With the war in Europe drawing to its inevitable but costly conclusion, automobile manufacturers are understandably formulating their plans for post-VE-Day resumption of operations and are also looking ahead to the years to follow. Rumors concerning these developments continue to run the gamut from sleek, plastic-bodied, transparent-topped cars to revived Ford Model A's, but informed sources heavily discount the former and question the strength of any continued demand for the latter.

Whatever does transpire, of course, is of great interest to the petroleum industry, since the latter must provide gasolines of whatever grade are required for the "cars of the future." In this connection, therefore, two recently-published articles are of special interest.

The first of these,[4] under a Detroit dateline, presents a summary of what automobile manufacturers are said to be thinking. Beginning with the statement that the first cars to be manufactured will be 1942 models altered only to an extent comparable to a normal year-to-year change, Cummings states that these changes will be chiefly ones in appearance—new, streamlined fenders; fancy grillwork; and different bumpers. New bearings developed in wartime may be applied, but present WPB restrictions rule out much possibility of major engineering developments, which normally come only every three to five years in any case.

Postwar Models No. 1, 2, 3, and 4 will be different, however. Cummings predicts the following trends: (1) smaller engines, weighing eventually as little as two pounds per horsepower as compared to the present average of six pounds; (2) less overall weight, somewhere between 2000 and 2500 pounds for cars of the type which now weigh 3000 pounds; (3) improved mileages, up to 30 miles per gal. when engines have been redesigned and cars made lighter; (4) numerous body styling changes, such as curved glass windshields and aerodynamic body designs; (5) rigid body construction; (6) automatic transmissions, expected to be standard equipment as soon as manufacturing costs can be brought down; (7) greater use of plastics, for example in the framework of front seats, but not for bodies in at least the predictable future; (8) longer wear, resulting from increased industry knowledge of metals and such processes as nitriding; and (9) sealed-in components, such as starters, generators, and (perhaps) whole engines.

Future engines, according to Cummings, will probably be built to use gasolines of 85-90 octane number. Such changes as fuel-injection, air-conditionnig, improved seat designing and construction, better upholstery, rear-engine design, and air-cooled engines are correctly reported as ones upon which opinion differs widely.

The second pertinent article on postwar automobiles is a report of a market analysis prepared by the Nash-Kelvinator Corp.[5] According to this analysis, some 34,000,000 passenger cars are expected to be on the road by 1950, some 6,400,000 more than before the war. A seller's market is expected for a period of three years after the war, with a peak output of 6,000,000 cars per year failing to keep pace with demands, but by the fifth postwar year it is believed that production will have declined to about 4,000,000 cars.

Nash estimates that about 24,900,000 cars were available on Jan. 1, 1945, including some 1,700,000 in storage. Some 9,100,000 cars would have to be manufactured between now and 1950, in addition to replace-

[3] Anon., *Patents*, Hearings Before the Committee on Patents, United States Senate, 77th Congress, Second Session, on S. 2303 and S. 2491, Superintendent of Documents (Washington), 1943.

[4] Cummings, G. H., *Wall Street Journal CXXIV*, No. 111, 1 (1944), "Dream Cars."

[5] Anon., *Automotive Industries* 91, No. 10, 52 (1944).

[6] Anon., *Wall Street Journal CXXIV*, No. 85, 15 (1944), "Wright Aeronautical To Make Gas Turbine Engines For Aircraft."

Houdry and TCC Processes are now licensed on a running royalty basis... 5¢ a barrel straight!

Expanding its service to industry, Houdry now offers a running royalty plan on its catalytic cracking processes—5¢ per barrel of fresh-feed charge, with no additional cost for recycling or treating for aviation gasoline. Thus, the plan covers any type of catalytic cracking operation regardless of end products.

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Los Angeles, Calif.

ments for the number scrapped before then, if its 1950 prediction is to be realized.

Aeronautical Gas Turbines

The Wright Aeronautical Corp. has recently announced[6] its entry into the gas turbine field for aircraft and, according to the announcement, may eventually produce engines up to 10,000 horsepower. Combinations of the direct jet plane and the turbine-engined, propeller-driven plane may also be worked out.

Wright engineers are said to believe that the gas turbine will be lighter than present power plants. Further, they will be able to use almost any type of fuel from kerosine to high-octane gasoline, although any purpose in using the latter appears obscure. Speeds of 500 to 600 miles per hour and ceilings of 30,000 to 40,000 feet are predicted for planes using such plants.

G. W. Vaughn, president of the corporation, has said that turbine-driven engines above 5000 horsepower offer "marked advantages" over reciprocating engines but that the turbine engine will not prove efficient for planes designed to fly at less than 375 miles per hour. "With real volume, the cost per horsepower should be somewhat less than for reciprocating engines, as there are fewer moving parts in the turbine power plant."

Although Wright does not expect to produce commercial jet and turbine engines until "the war effort has been taken care of," its projected entry into this field lends added weight to the argument that the petroleum industry should give careful attention to this new mode of power generation.

Petroleum Butadiene

It is now a generally-accepted fact that butadiene can be made more cheaply from petroleum than from any other abundant raw material, although alcohol-butadiene may not be much more expensive if waste carbohydrate sources such as blackstrap molasses are ever again available at distress prices. Recognizing this fact, proponents of "synthetic rubber from farm crops" have taken another tack and are now decrying the use of such an expendable material as petroleum for the production of a chemical which can be made from agricultural materials—at a price.

A quotation from a British journal[7] is of interest in this connection:

"A question has been asked in the U. S. as to whether there will be enough petroleum available after the war to permit the extensive production of synthetic rubber tires. The Ethyl Corp. has, however, pointed out that 16 gallons of butylene, which is a petroleum product obtained in large quantities, will form the basis of the four tires for an average motor car, and these will, it is estimated, run for at least 20,000 miles. Fuel requirements for the same vehicle, taken at 15 m.p.g. over this distance, would be 1,333 gallons, which represents about 90 times the amount which would be required in the construction of the tires. Considered from this aspect, the consumption in connection with the production of synthetic rubber would be inconsiderable."

It should further be noted that the above figures are conservative. Recently-announced American Automobile Association tests[8] have shown that under reasonably good driving conditions a minimum mileage of 37,500 miles may be obtained from standard GR-S tires, while at least 22,500 additional miles can be obtained by use of a Grade C recap (32-38% synthetic rubber). On the other hand, cars of the future will certainly average more than 15 m.p.g.

To further refute the implication of wastefulness, one need only look at the product distribution tables obtained by petroleum substitute processes. These figures reveal abundant yields of C_4 hydrocarbons, which yields are augmented when the liquid substitutes are subjected to such standard refining processes as cracking, reforming, and destructive hydrogenation. Thus no shortage of C_4 hydrocarbons may be expected when our supplies of crude petroleum become insufficient to meet total domestic demands, and recycling and natural gasoline operations may be expected to supply large quantities long after this period is reached. Still further, butylenes and gasolines are far from synonymous, since gasolines made from the former, while of premium octane numbers, give little promise of competing on an economic basis in the general automotive market for at least some years.

The whole butadiene question is immeasurably complex. Problems of domestic security and international harmony compete with questions of relative elastomer costs and qualities, and a dispassionate attitude toward eventual solution would seem vital to the nation and to the world. Pressure politics, however, have a way of playing hob with technical and economic problems, so no one can safely predict what the outcome of such matters will be.

Synthine Production

The petroleum industry must view with caution, for a time at least, all reports that various interests are ready to begin production of Synthine (Fischer-Tropsch) products on a commercial scale from natural gas. It is undeniably true that many petroleum, natural gas, and engineering companies are engaged in research on this problem, some at the pilot-plant level, but no authentic claim has yet been made that technical developments have advanced to the point where the process will be competitive with petroleum at its present cost.

The point in question concerns a widely-publicized report that Fred C. Koch, consulting engineer of the Winkler-Koch Engineering Co., has announced that he intends to erect a Synthine plant which would use as raw material natural gas from the Hugoton field of Kansas and Oklahoma. According to this report, "plans are still in the tentative stage," although 100,000 acres of the Hugoton field were reported to have been leased and the Champlin Refining Co. was said to have "tentatively agreed to go into the project."

This report has evoked a letter from Koch to one of the petroleum journals[9]. It would seem from this letter that his activities "have been given a great deal more publicity than they warrant". Koch states that a block of acreage in the Hugoton area has been assembled with the intent of eventually utilizing it for a Synthine plant but that much remains to be done in the way of experimental work and financing before it can be undertaken. In Koch's own words, "it is definitely a long range proposition and is nothing to get excited about for the present."

Be this as it may, the interest now aroused in the Synthine process seems based upon sound premises of its technical worth. R. P. Russell of the Standard Oil Development Co. recently testified before a subcommittee of the Senate Committee on Public Lands and Surveys that the European-developed Synthine process could compete with petroleum at $2.00 per barrel for the production of gasoline and that such gasoline in a plant of "possible future design" might be produced for as little as 4.8 cents per gallon, but these figures have not yet been proved by large-scale production nor are all other authorities in complete agreement with them.

Even eight cents a gallon does not appear an unreasonable cost for gasoline, however, for crude prices will probably not remain for long at their present low level.

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[7] Anon., *Commercial Motor* 80, No. 2062, 130 (1944), "Comparison Between Petroleum Used for Tires and for Fuel."

[8] Anon., *NATIONAL PETROLEUM NEWS* 36, No. 47, 20 (1944), "Synthetic Tires Good for Minimum of 37,500-Miles, A.A.A. Says After Test Tours."

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Life Testing of Lubricating Oil*

By H. C. Mougey**

Conventional laboratory tests, such as viscosity, flash, fire, etc., are of value as identification tests and for such purposes as checking uniformity of shipments and controlling refinery processes. In some cases there is a certain amount of correlation between these tests and performance in service, but "they do not demonstrate the value of oil under practical conditions". However, by a combination of laboratory tests, identification tests and engine tests under controlled conditions, it is possible to predict the performance of an oil.

ONE of the differences in behavior between the human race and the lower animals is the practice in which members of the human race frequently indulge of trying to predict the future. When no apparatus is used this practice is called "Thinking" or "Worrying". In another method in which only a small amount of glass apparatus is used, it is called "Crystal Gazing". In another method in which the glass apparatus is a little more elaborate, it is called "Chemical Analysis", and in another method in which the apparatus is still more elaborate, it is sometimes called "Life Testing". None of these methods are always 100% perfect, but by using combinations of these and other methods, it is frequently possible to make very accurate predictions.

Of course, the real distinction between these different kinds of testing does not lie in the type of apparatus, but rather in the kind of testing that is done. If we want to know whether an apple is good to eat we may examine it for certain properties, such as color, shape, hardness, etc. We may then predict from these tests, which are valuable for identification purposes, whether or not the apple is good to eat. However, there is an old saying, "The proof of the pudding is in the eating", and by actually eating the apple we may determine with a much greater degree of accuracy whether or not it is good to eat.

If we are interested in oil instead of apples, we may use somewhat analogous test procedures. We may determine the properties of an oil and predict its performance from these properties. This practice is followed in using the conventional oil specifications. However, we may also evaluate the oil by determining whether or not it will actually be satisfactory in use in an engine under known operating conditions. If we do not want to make an elaborate test, we may determine how the oil performs in some kind of apparatus in which we try to simulate actual service, or at least some of the factors of actual service. In the ideal laboratory life test all factors promoting deterioration or failure are greatly intensified, while their correct relation and sequence are maintained. Life tests and accelerated laboratory tests serve a useful purpose insofar as they give information in a much shorter time, facilitate the testing of a much larger number of products than would be possible otherwise, help eliminate unsuitable materials, and afford a more intelligent selection for service tests and future use.

The importance of engine oils has been recognized since the very early days of the automotive industry, but the difficulties in testing oils have also been recognized. At a meeting of the S.A.E. in 1909 Prof. Carpenter said,[1] "There is no known testing, I think, in the world which can give as erroneous opinions or give as erroneous results as what we get in testing oils."

Although much progress has been made during the 35 years since these remarks were made, the subject is still rather difficult.

The first S.A.E. specification for automobile engine oil that I can find is Spec. No. 26, which is printed in the Transactions of the Society of Automobile Engineers for 1910.[2] It is shown in Fig. 1.

It will be noted that this specification, for all practical purposes, simply limits the oil to one of from 40 to 50 sec. at 210° F., from a limited type of crude of high Baume gravity. It infers that almost any oil of this viscosity range made from this crude will be satisfactory and any other oil made from any other crude will be unsatisfactory. However, the oil and automotive industries soon learned that these assumptions took in too much territory from the standpoint of actual facts and too little territory from the standpoint of source of crude.

In 1913[3] Tipper pointed out that although these conventional laboratory tests are of value in checking uniformity of shipments and controlling refinery processes, and in some cases there is a certain amount of correlation between these tests and performance in service, "they do not demonstrate the value of oil under practical conditions". This same point has been made very many times since these early days. This is the theme of two of the most popular pieces of literature of the A.S.T.M., a paper given in 1928 by R. E. Wilson and D. P. Barnard on "The Significance of Various Tests Applied to Motor Oils",[4] and the A.S.T.M. 76-page publication, "Significance of Tests of Petroleum Products".

Although some of these tests may give us valuable information in regard to certain properties of an oil, it has been found by experience that the performance of an oil in service depends upon a large number of properties, and an oil is like a chain, it is no stronger than its weakest link. Consequently, although an oil may be excellent in respect to a number of tests, it may still be unsatisfactory in service due to a weakness in one or more other respects.

One of the most important properties of lubricating oil is resistance to oxidation at elevated temperatures. At the Michigan-Life Conference on Transportation, M. R. Fenske[5] tabulated both the usual inspection data and also a hydrocarbon type analysis on some commercial 10-W oils. These data did not include specific tests to determine resistance to oxidation, and although he listed 21 different tests on each of these oils, Prof. Fenske said: "However, giving full consideration to all the data set forth . . . there is still nothing to indicate the behavior of these oils from oxidation."

This lack of information in regard to the oxidation characteristics of oils is not due to any lack of work on oxidation tests. A number of years ago the library of The Texas Co. compiled a report in which various oxidation tests that had been proposed were tabulated. Over 200 different tests were described, and since that time many additional oxidation tests have been developed. However, there are several fundamental reasons why laboratory oxidation tests may not always correlate with service. One of these reasons is found in the effects of catalysts and inhibitors.

In order to keep the laboratory test results from varying due to the catalytic effect of metals picked up from the test apparatus, many tests are made in glass, but in actual use the oil may pick up catalysts from the engine which, of

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course, is largely iron. In one test which we made,[6] it was found that a certain very highly refined oil without any added oxidation inhibitor oxidized and caused very bad bearing corrosion in an engine on the road in less than 1000 miles, although the oil stood a test of 200 hours in glass with pure oxygen at 350°F. with no appreciable effect.

At the 1939 meeting of the American Chemical Society, Downing, Holbrook and Fuller[7] reported tests which showed that the method of cleaning the engine prior to making a test might greatly influence the results. They reported that much more deterioration of the oil took place in their tests when the engines were cleaned with a water solution of an alkali cleaner than when the engines were cleaned by washing with gasoline.

To determine the effect of catalysts, tests are sometimes made with the addition of various amounts of different metals or metal compounds. However, different oils are affected differently by the various metals. One oil may be very repellant to the effects of iron and very susceptible to the effects of copper. The effects of these two metals may be just reversed with another oil. Still another oil may be very resistant to both metals or greatly affected by both metals. Consequently, in studying the effects of catalysts it is desirable to run a number of tests with increasing amounts of different metals and then plot curves from the data to learn how the oils are affected by different amounts of the various metals.

Another trouble in connection with trying to correlate laboratory tests with performance in service is caused by the effects of inhibitors which may be carried over in an engine from one test to another. In some cases it has been found that oxidation did not occur in road tests with oils which showed very poor oxidation resistance in laboratory tests. Some of these results were due to the effects of inhibitors used in the previous tests in the engines not being cleaned out of the engines prior to the later tests. One of the very important factors in these tests is the proper cleaning of the test devices and actual engines so that the oil will not be rated too low due to the catalytic effect of too much metal pick-up from the apparatus or the engine, or rated too high due to the carry-over of inhibitor from previous tests.

Another reason why laboratory tests do not always check with service is due to the effects of variations in the operating conditions. There are a large number of operating conditions that must be controlled in a laboratory test if it is to check with actual service. Of course, the only way in which we can be sure that a laboratory test will check with a service test is to duplicate absolutely everything in the service test, including apparatus, time, temperatures, cycle of operations, etc. However, this would mean that the laboratory test and the service test would be identical and nothing would be gained in making a laboratory test instead of simply *observing* what happens in actual service. At the meeting of the American Chemical Society in New York, Sept., 1944, a symposium was held on "Bench Scale Techniques". A number of the papers[8] given at this symposium were on life testing of engine oils, and they are worthy of very careful study by all who are interested in this subject.

Although some of these laboratory bench tests are of great value in predicting the performance of oils, the final measure of quality of an oil always must remain "performance in service". It may be objected that actual tests under service conditions are too expensive in time and money, but it is possible to make engine tests in laboratories under controlled conditions; and from the results of these laboratory engine tests, very good predictions as to performance in the various kinds of service can be made.

Of course, engine tests made in the laboratory are not "performance in service". They are simply engine tests under controlled conditions. But there is no such thing as a standardized "average performance in service". Each engine running in service is different from every other engine in service in some respect. The only real difference between a controlled engine test in the laboratory and a road test or performance in service is due to the fact that in the laboratory we have more control over the various engine and operating conditions. There is no fundamental difference between an engine operating in service and a laboratory engine test except for the fact that we usually think we know more about the conditions of a laboratory test. There is a real danger, however, in predicting from a laboratory test under known conditions as to what may happen in service under some different and unknown conditions. There is also just as much danger in predicting from a road or service test under some unknown conditions as to what will happen under all the various unknown conditions in actual service.

Laboratory engine tests have been under development for a number of years. They have been studied in the various laboratories of the oil and automotive industries and they have been studied by committees of the S.A.E., C.R.C., and A.S.T.M. When the Army and Navy were confronted with the problem of obtaining large amounts of oil for use all over the world in a variety of engines, they both developed specifications based on both the conventional tests of viscosity, flash, etc., in order to classify the oils, and also on engine tests to help in predicting the performance of the oils under actual service conditions.

The Navy Specification, 14-0-13 (Int), specifies among other tests:

"Diesel engine lubricating oil shall be tested for periods of not less than 300 hours in 3 or more types of one-cylinder Diesel test engines, and for periods of not less than 500 hours in 2 or more types of full-size Diesel engines." This specification also states that these engine tests will not be required on the SAE 10 and SAE 50 grades of Diesel oil provided evidence is submitted showing that the oils of these two grades have been approved under the U.S. Army specification, which also requires engine tests.

The U.S. Army Specification, 2-104B, like the Navy Specification, requires that the oils must meet certain conventional tests and in addition a number of actual engine tests. These tests are the L-1 to L-5 tests of the C.R.C.[9] These various engine tests have been described in a number of papers by representatives of the U.S. Military Forces.[10] In these papers reports are also given of the excellent performance of these lubricants in service.

Since engine tests determine the performance of the oils only under the test conditions, and since the Army oils are used in a number of different types of engines under a wide variety of operating conditions, 5 different engine tests using 5 different kinds of engines are specified.

These tests and the operating conditions are selected on the basis of accelerated tests under the conditions which are of the greatest severity and importance in respect to the factors being tested. The first test, which is known as the L-1 Caterpillar test, is made using a single-cylinder Caterpillar engine operated at 1000 RPM for 480 hours with the oil temperature at 145°F. and the jacket water at 175°F. The test is to evaluate the oil in respect to ring-sticking, wear, and detergency in a Diesel when tested at comparatively low oil temperature.

Under these test conditions, using a

Fig. 1—Automobile Engine Lubricating Oil

Specification No. 26

Oil for this purpose must be a pure mineral oil, no addition or adulterant of any kind being permitted.

The following characteristics are desired:

Specific Gravity	28° to 32° Baume
Flash Point, not less than	400° F.
Fire Test, not less than	450° F.
Viscosity at 100° F., Saybolt Viscosimeter, not over	300 seconds
Viscosity at 210° F., Saybolt Viscosimeter	40 to 50 seconds
Viscosity at 210° F., Tagliabue Viscosimeter	60 to 65 seconds
Carbon Residue, not over	0.50%

Trans., Soc. of Auto. Eng., 1910, Vol. 5, p. 174.

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straight mineral oil, there will usually be considerable trouble due to varnish, ring-sticking, and carbon deposits; but if a good oil containing oxidation inhibitor and detergent is used, the piston will be clean and the rings free with little or no carbon deposits.

The L-2 Caterpillar test is made in a single-cylinder Caterpillar engine, using a special piston and injector, at 900 RPM for 3 hours with the oil at 140°F. and the jacket water at 175°F. The test is to evaluate the oil in respect to load-carrying and performance under accelerated run-in and high load at comparatively low oil temperature.

The L-3 Caterpillar test is made in a multi-cylinder Caterpillar engine, at 1400 RPM for 120 hours, with the oil at 212°F. and the water at 200°F. It evaluates the oil in respect to detergency and bearing corrosion at moderate oil temperatures.

The L-4 Chevrolet test is made in a multi-cylinder Chevrolet engine, at 3150 RPM for 36 hours, with the oil at 280°F. and the water at 200°F. It measures resistance to oxidation, bearing corrosion, and general engine cleanliness when tested at high oil temperature using gasoline containing tetraethyl lead. Under these test conditions, using a straight mineral oil that is not good in resistance to the formation of varnish and sludge, the piston and engine parts will be badly sludged and varnished, but if a good heavy-duty oil is used, the piston and engine parts will be clean.

Of course, it is possible to produce an oil which is poor in resistance to oxidation but which is good under the L-4 test conditions in respect to the formation of varnish and sludge, and such an oil may give a clean engine in the L-4 test. However, the weakness of such an oil in resistance to oxidation will still be shown in this test by the poor used oil analysis and by corrosion of the test copper-lead bearings.

The L-5 General Motors Diesel test is made in a multi-cylinder Diesel at 2000 RPM for 500 hours, with the oil at 230° F. and the water at 200°F. It measures ring-sticking, detergency, and bearing corrosion at moderately high oil temperature.

Since the operating conditions in most actual service are less severe than these test conditions, it follows that if the oils are satisfactory in these tests they will probably be satisfactory in actual service, provided the oil of the right classification for the service is used and provided some unusual factor or condition for which the oil is not responsible is not encountered. As an illustration, an oil might be satisfactory in all these tests and yet trouble might be experienced in a gasoline engine if the gasoline is of too poor quality in respect to gum content, volatility, or octane rating; but such difficulties should be charged to the gasoline and not to the oil. As another illustration, the oil might meet all the requirements for the SAE 30 grade and yet it might be too high in viscosity to permit starting at low temperatures if the correct classification for the engine and operating temperature should be SAE 10 or diluted SAE 10.

An illustration of a possible difficulty due to some unusual factor which might be overlooked in a limited amount of testing is resistance to rusting in the presence of water. It is well known that water will collect in the crankcase if an engine is operated at too low jacket and crankcase temperatures, and it is also known that the tendency of this water to cause rusting of the engine parts may be influenced by the rust-resisting properties of the crankcase oil. However, all of the engine tests L-1 to L-5, inclusive, are made at temperatures above those at which water will condense in the crankcase.

At the first glance it might appear that factors like this have been over-looked in the Army Specification 2-104B, but this specification contains two separate paragraphs which state that in addition to the tests that are specified, the Ordnance Department may require any additional tests that it feels are desirable. Whenever an oil company submits a lubricant that is enough different from those on which the Ordnance Department has actual service experience under a wide variety of operating conditions, such a lubricant is examined with special care and extra tests are required before a decision is made in respect to the lubricant.

Oils which have the proper chemical and physical properties so that they can meet the laboratory and engine tests given in these Army and Navy Specifications are known as heavy-duty oils. They are used in all Navy Diesel engines and in all of the engines of the U. S. Ground Forces, both gasoline and Diesel. They are also used very generally by civilians in diesels and in gasoline trucks and buses, but on account of the importance of these lubricants for use in the Military engines, and because their manufacture requires certain critical materials, they are not available at present at the filling stations for use by civilians in passenger cars. However, after the war, when these limitations no longer are in effect, it is probable that heavy-duty oils will be used very largely in all kinds of internal combustion engines wherever the service requirements are so severe that ordinary mineral oils will not give satisfactory performance.

From this discussion it is evident that the oil and automotive industries have come a long way since the adoption of the first S.A.E. Specification for Engine Oil 35 years ago. We have learned to appreciate the various factors connected with suitability of the oil and quality of the oil, and we recognize the importance of the engine and operating conditions. In standardized engine tests we have learned how to select and control most of these conditions, and in actual service we have learned much about the effects of uncontrolled variations in these conditions, and how to manufacture and select oils that will give satisfactory performance under the various service conditions.

Throughout these years the men in the oil and automotive industries have learned how to cooperate in studying their mutual problems, and we have learned that although it is possible to make good predictions in respect to an oil by considering such factors as identification tests and life tests, we should not overlook certain other factors, such as the earnest desire of a company to produce products of high quality. The slogan adopted by one of the large drug companies is of equal importance when applied to lubricating oils,

"The most valuable ingredient of any product is its maker's good name."

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MULTICOMPONENT FRACTIONATION:

A Simplified Approach to Plate-to-Plate Calculations*

By H. H. Hummel**

Rigorous results for multicomponent fractionation are obtained by what is essentially a modified, more convenient plate-to-plate calculation. The trial and error is thrown primarily into an assumed temperature gradient throughout the column, rather than into the distribution of components. Successive approximations are made to the temperature gradient until a satisfactory check is obtained, only two or three trials usually being necessary.

The calculation is particularly suited for predicting the performance of an existing tower, although it is also useful for calculating the number of plates required for a desired separation. It will be of greatest value where the usual plate-to-plate calculations are otherwise required, especially when there are a number of distributed components.

While major attention is given to ideal systems, a suggested approach for certain types of non-ideal systems is outlined.

A CONSIDERABLE number of articles on multicomponent fractionation have appeared in the literature, testifying both to the importance and to the difficulty of the subject. These contributions have in general developed the subject from two points of view. The first is that of the rigorous plate-to-plate procedure and the second is that involving simplifying assumptions and approximations designed to expedite the work. The latter procedures have sacrificed the exactness of the rigorous method for the advantage of speed and the avoidance of the tedium of the plate-to-plate method. In addition, the simplified methods presented previously do not lend themselves to the handling of the important problem involving the calculation of "sloppy" fractionations, in which there are several overlapping components present in both the overhead and bottoms fractions. It seems generally true that the literature thus far has concerned itself only with the determination of the number of plates required to effect a given separation. The reverse problem, the calculation of the overhead and bottoms composition from a given feed with a given number of theoretical trays, has been neglected even though in the case of an operating plant, because of changes of feed stock or operating conditions, it is of more importance than the classical problem.

This paper presents a method of conveniently handling either of the problems indicated above. The procedure retains the accuracy of the plate-to-plate method and at the same time eliminates much of the detail and labor ordinarily associated with this accuracy. It is believed that the method offered is particularly well adapted for the handling of "sloppy" separations in existing equipment, although it is not limited to this application. It should be helpful generally for dealing with problems in fractionation, the complexity of which has hitherto necessitated the use of complete plate-to-plate calculations. Problems of this nature, often involving many components with a number of them distributed, occur frequently in the petroleum and petroleum chemical industries.

The proposed method, which may be described as a modified plate-to-plate calculation in which the trial and error process occurs primarily in the temperature gradient in the tower rather than in the distribution of components will be illustrated by an example involving the superfractionation of a naphtha cut in an existing tower. The slightly different procedure necessary for the calculation of the number of theoretical plates corresponding to a fixed separation and a given reflux ratio will be briefly indicated. In addition a suggested approach for application of the method to an important type of non-ideal system will be outlined.

The development described in this paper has been aided by ideas previously given in the literature by a number of authors [2,3,8,10,12], Thiele and Geddes[12] have suggested that a trial temperature be assigned to each plate, enabling simple and rapid fractionation calculations to be made. They then state that these temperatures may be checked by proper judgment and by trial and error calculations. The present paper presents not only a straightforward method of assigning trial temperatures to the plates but also a definite procedure for checking and correcting these temperatures. The calculation parallels to some extent that outlined by Jenny[8], an important difference being that in the present instance temperature as represented by equilibrium K values for a reference component is plotted as a function of plate number, while in Jenny's method a plot of y vs. x for the key component is prepared.

I. Calculation of the Distribution of Components for an Existing Tower for Ideal Systems

Explanation of Method

When the equilibrium K value for a component is known for every plate in a distillation tower, the fractionation of that component can be calculated very easily, provided that reflux rate is likewise known on every plate. Consider two plates n and $n + 1$ in a rectifying section, n being the upper. Then the operating line equation may be written

$$v_{(n+1)} = l_n + d$$

From the definition of K it follows that

$$v_{(n+1)} = l_{(n+1)} \left(\frac{KV}{L}\right)_{(n+1)}$$

Then

$$l_n + d = l_{(n+1)} \left(\frac{KV}{L}\right)_{(n+1)}$$

or

$$\frac{\frac{l_n}{d} + 1}{\left(\frac{KV}{L}\right)_{(n+1)}} = \frac{l_{(n+1)}}{d}$$

Similarly, in a stripping section where plate m is below $m + 1$, it is readily shown that

$$\frac{\frac{v'_m}{b} + 1}{\left(\frac{L'}{KV'}\right)_{(m+1)}} = \frac{v'_{(m+1)}}{b}$$

Once values of KV/L or L'/KV' are known on each plate and l/d or v'/b known at some point in a section of a fractionating column, the calculation to another point by the use of these simple relations proceeds very rapidly.

It is assumed for the time being that constant molal overflow exists in the tower, although later a means of handling variations in overflow will be suggested. The problem of calculating multicomponent fractionation may then in essence be resolved into one of finding equilibrium K values for the various components throughout the tower. In an ideal vapor-liquid

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system at constant pressure the K values for all components are fixed by fixing that of any one, which also sets the temperature. Hence a plot of equilibrium K value for some component against plate number in the tower, which is equivalent to a plot of temperature, gives all the information needed for complete and rapid fractionation calculations. These calculations will be rigorously correct, however, only if the curve of K against plate number is consistent with the operating conditions of the tower. The following discussion is devoted to describing the trial and error procedure necessary to obtain such a curve, and the manner of using it to calculate fractionation.

Outline of Calculation

The following procedure is for the case where all operating conditions for an existing tower have been set and it is required to find the composition of overhead and bottoms.

1. One of the components, preferably one whose distribution is important, is selected for reference for relative volatilities.

2. A first approximate curve of K for the reference component, K_r, against plate number is prepared. To obtain points on this curve at the top and bottom of the tower, a reasonable splitup of the charge into overhead and bottoms is assumed, and plate-to-plate calculations made for several equilibrium plates at the top and bottom. A means of obtaining first approximate K_r points in the vicinity of the feed plate is described in the example problem. With the aid of these points the curve for the entire tower is sketched in.

3. Using the curve, simplified fractionation calculations are made, leading to corrected overhead and bottoms compositions and a complete feed plate composition.

4. Starting with the compositions just obtained, plate-to-plate calculations are made for several plates at the top and bottom of the tower and above and below the feed plate, giving K_r points to check the original curve. If a satisfactory check is obtained the calculated fractionation may be taken as correct.

5. If the check is not satisfactory, a corrected K_r curve is drawn using the check points themselves, and this curve is used in the same manner as the first one. The process is repeated until a satisfactory check is obtained. No more than two or three such trials should be necessary.

Example Problem

The method will be illustrated by an example which would offer difficulties if attempted by the ordinary plate-to-plate calculation. The problem may be described as a superfractionation of a narrow boiling hydrocarbon mixture. The charge is to be fractionated in an existing tower and the cut point is set by fixing the distribution of one of the components. The problem is to determine the distribution of the other components at a fixed operating pressure. The simplifying assumption is made that constant molal overflow exists, but variations could be taken into account if desired.

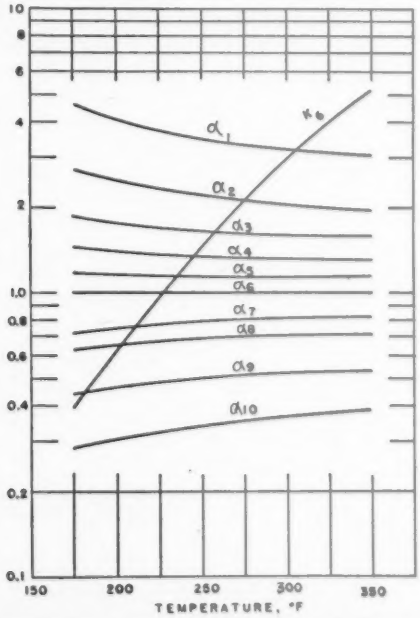

Fig. 1—Equilibrium Data for Example Problem. Relative volatilities for the various cuts and the equilibrium constant for the reference Cut 6 are given as a function of temperature at a pressure of one atmosphere

Tabulated data concerning the problem are:

Tower—30 theoretical trays plus reboiler with trays numbered from bottom.
Feed tray—No. 15
Internal reflux, rectifying section—1500 mols/hr.
Internal vapor, stripping section—1500 mols/hr.
Feed, 1000 mols/hr. composed of 10 cuts each of 100 mols/hr. identified as Cuts 1-10 inclusive.

Required: 2 mols/hr. of Cut 4 to appear in the bottoms fraction and other components to be determined.

In Fig. 1 the volatilities of the various cuts relative to Cut 6, the assumed reference component, are shown as a function of temperature at the tower pressure (assumed constant), together with a plot of equilibrium K values (K_r) for the reference component, Cut 6.

The first step in the calculation is to assume a split-up of feed into overhead and bottoms, as follows:

Cut	Mols/Hr. f	Mols/Hr. d	Mols/Hr. b
1	100.0	100.0	.....
2	100.0	100.0	.....
3	100.0	100.0	.....
4	100.0	98.0	2.0
5	100.0	65.0	35.0
6	100.0	40.0	60.0
7	100.0	5.0	95.0
8	100.0	.....	100.0
9	100.0	.....	100.0
10	100.0	.....	100.0
	1000.0	508.0	492.0

On the basis of the assumed overhead and bottoms compositions, temperatures, or rather values of K_r,* are calculated for several equilibrium steps at the top and bottom of the tower, employing the method of Robinson and Gilliland[11]. These calculations are shown in Table I-a.

If the calculations had been continued in this fashion for a large number of plates without the introduction of other components, a maximum temperature would be obtained in the rectifying section and a minimum temperature in the stripping section, at which all components would have a constant composition from one plate to the next. This temperature may be determined in the rectifying section by applying to each component the equation $(l/d)\ (KV/L - 1) = 1$, finding the temperature at which $\Sigma l = L$. Similarly the equation $(v'/b)\ (L'/KV' - 1) = 1$ is applied in the stripping section. This calculation is shown in Table I-b.

Jenny[8] has pointed out that the constant composition temperature may usually be sufficiently closely approximated by setting $KV/L = 1$ for the heaviest component in the overhead and $L'/KV' = 1$ for the lightest component in the bottoms. This is true in the present case.

The results of these calculations are summarized as follows:

Rectifying Section		Stripping Section	
Plate	K_r	Plate	K_r
30	0.575	B	1.487
29	0.656	1	1.342
28	0.704	2	1.262
Const. Comp.	0.970	Const. Comp.	0.956

Curves are now drawn in Fig. 2 for K_r in the rectifying and stripping sections, using the calculated points at the top and bottom of the tower and drawing the curves asymptotic to the respective values representing constant composition. Since no account was taken of non-distributed heavy components in the rectifying section or of non-distributed light components in the stripping section in drawing these curves, and as these com-

*It will be recalled that K for the reference component at equilibrium when relative volatilities are used is simply the reciprocal of the molal average α. That is, since equilibrium $\Sigma x = \Sigma Kx = 100$, and since $\alpha = K/K_r$, where r refers to the reference component, then $\Sigma x = K_r \Sigma_\alpha x = 100$ and $1/K_r = \Sigma_\alpha x/100 = {}_\alpha$av. or $K_r = 1/{}_\alpha$av.

X-RAY OF ACCURACY!

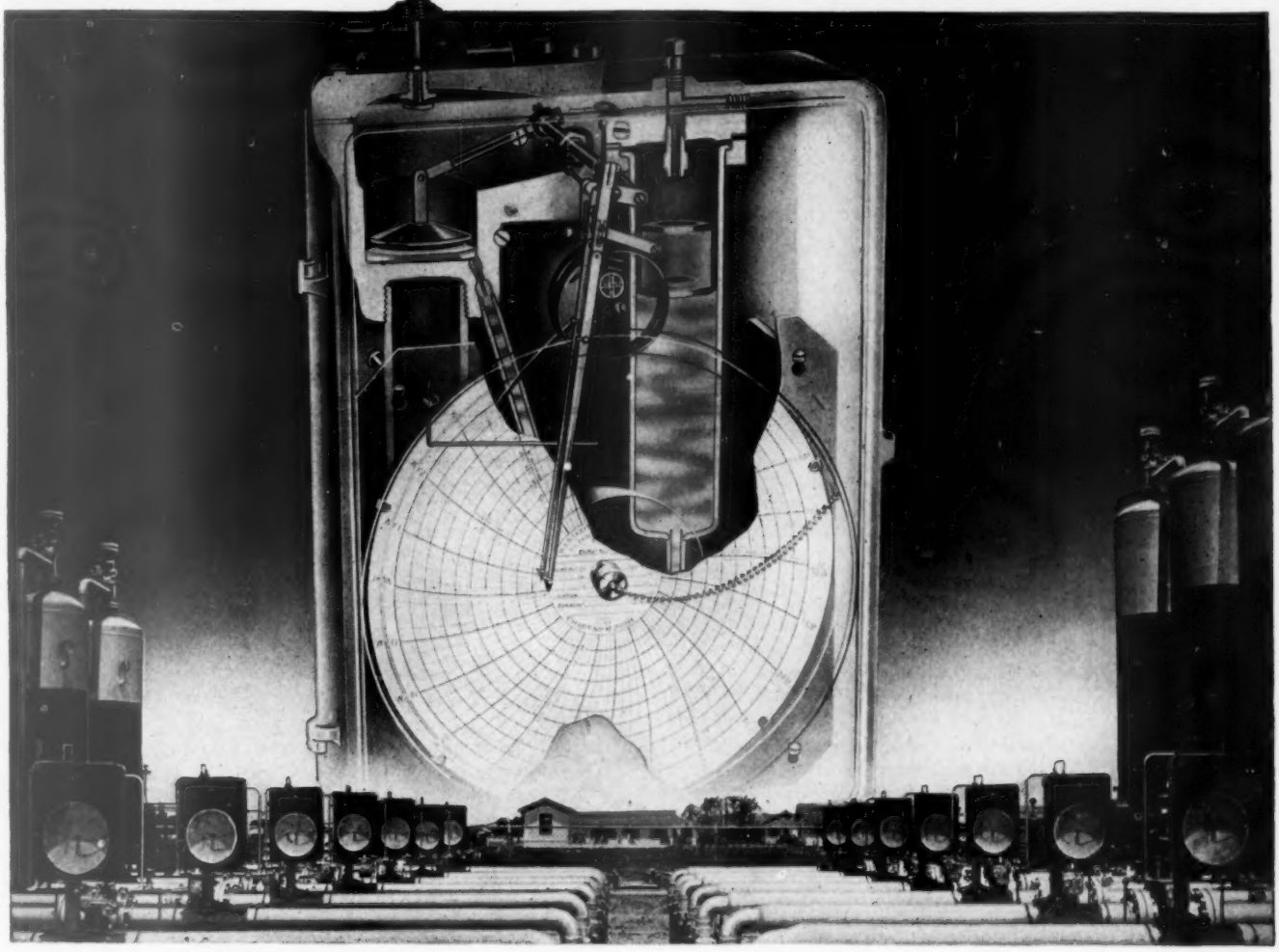

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TABLE I-a—Calculation of Temperature Points at Top and Bottom

Cut	f	d	b	α	b_α	v'_B	l'_1	α	$l'_{1\alpha}$	v'_1	l'_2	α	$l'_{2\alpha}$	v'_2	v'_2/b
1	100.0	100.0	....	....	....	.....	.....	....	.....	.....	.....	.....	.....	.....	....
2	100.0	100.0	....	....	....	.....	.....	....	.....	.....	.....	.....	.....	.....	....
3	100.0	100.0	....	....	....	.....	.....	....	.....	.....	.....	.....	.....	.....	....
4	100.0	98.0	2.0	1.37	2.7	12.2	14.2	1.37	19.4	19.6	21.6	1.37	29.6	28.2	14.1
5	100.0	65.0	35.0	1.16	40.6	184.0	219.0	1.16	254.0	256.0	291.0	1.16	337.0	321.0	9.17
6	100.0	40.0	60.0	1.00	60.0	272.0	332.0	1.00	332.0	335.0	395.0	1.00	395.0	376.0	6.26
7	100.0	5.0	95.0	0.790	75.1	340.0	435.0	0.790	344.0	347.8	442.8	0.790	350.0	330.0	3.48
8	100.0	....	100.0	0.690	69.0	312.5	412.5	0.690	285.0	288.0	388.0	0.690	268.0	.....	....
9	100.0	....	100.0	0.500	50.0	226.2	326.2	0.500	163.0	164.8	264.8	0.500	132.4	.....	....
10	100.0	....	100.0	0.342	34.2	155.0	255.0	0.342	87.4	88.2	188.2	0.342	64.4	.....	....
	1000.0	508.0	492.0	.....	331.6	1501.9	1993.9	.....	1484.8	1499.4	1991.4	.....	1576.4	.....	....

$(K_r)_B = 492.0/331.6 = 1.487$ $(K_r)_1 = 1993.9/1484.8 = 1.342$ $(K_r)_2 = 1991.4/1576.4 = 1.262$

Cut	d	α	d/α	l_{30}	v_{29}	α	v_{29}/α	l_{29}	v_{28}	α	v_{28}/α	l_{28}	l_{28}/d
1	100.0	4.10	24.4	125.0	225.0	4.10	55.0	62.6	162.6	4.10	39.6	.....	....
2	100.0	2.50	40.0	205.0	305.0	2.50	122.0	139.0	239.0	2.50	95.5	.....	....
3	100.0	1.77	56.5	290.0	390.0	1.77	220.2	251.0	351.0	1.77	198.5	.....	....
4	98.0	1.40	70.0	359.0	457.0	1.40	327.0	372.0	470.0	1.40	336.0	356.0	3.64
5	65.0	1.18	55.0	282.0	347.0	1.18	294.0	335.0	400.0	1.18	339.0	360.0	5.54
6	40.0	1.00	40.0	205.0	245.0	1.00	245.0	279.0	319.0	1.00	319.0	338.0	8.45
7	5.0	0.750	6.7	34.8	39.8	0.750	53.0	60.4	65.4	0.750	87.2	92.5	18.5
	508.0		292.6	1500.8	2008.8		1316.2	1499.0	2007.0	.....	1414.8	.....	....

$(K_r)_{30} = 292.6/508.0 = 0.575$ $(K_r)_{29} = 1316.2/2008.8 = 0.656$ $(K_r)_{28} = 1414.8/2007.0 = 0.704$

TABLE I-b—Determination of Temperature of Constant Composition

Cut	d	α	KV/L	$l = d/[(KV/L) - 1]$
1	100.0	3.75	4.86	26
2	100.0	2.35	3.05	49
3	100.0	1.70	2.20	83
4	98.0	1.39	1.80	123
5	65.0	1.17	1.52	125
6	40.0	1.00	1.30	133
7	5.0	0.77	1.005	961
	508.0	....	....	1500

Constant Composition $(KV/L)_r = 1.30$
$V/L = 1.34$ $K_r = 1.30/1.34 = 0.970$

Cut	b	α	L'/KV'	$v' = b/[(L'/KV') - 1]$
4	2.0	1.39	1.002	871
5	35.0	1.17	1.20	175
6	60.0	1.00	1.39	154
7	95.0	0.77	1.80	119
8	100.0	0.68	2.04	96
9	100.0	0.49	2.84	54
10	100.0	0.33	4.20	31
	492.0	....	....	1500

Constant Composition $(L'/KV')_r = 1.39$
$L'/V' = 1.33$ $K_r = 1.33/1.39 = 0.956$

ponents will gradually affect the plate temperature as the feed plate is approached, a correction must be made to the asymptotic curves to obtain the true K curves. In ordinary plate-to-plate calculations this is taken care of by a trial and error matching in of these components as the feed plate is approached. In the present method a first approximation to this effect is obtained as follows:

From the curves already drawn it appears that the feed plate K_r, which has already been set by the other conditions fixed in the problem, will be in the neighborhood of 0.970. Using this as a first approximation, the amounts of heavy and light non-distributed components on the feed plate are calculated in the usual manner by applying the equations of constant concentration.

Feed Plate $K_r = 0.970$ $V/L = 2008/1500 = 1.340$
$L'/V' = 1992/1500 = 1.330$

Cut	α	K	KV/L	l/d	d	l	x
1	3.70	3.59	4.81	0.262	100.0	26.2	1.75
2	2.33	2.26	3.03	0.492	100.0	49.2	3.26
3	1.70	1.65	2.21	0.827	100.0	82.7	5.51

Cut	α	K	L'/KV'	v'/b	b	v'	l'	x
8	0.680	0.660	2.01	0.991	100.0	99.1	199.1	10.0
9	0.490	0.475	2.80	0.555	100.0	55.5	155.5	7.8
10	0.330	0.320	4.15	0.317	100.0	31.7	131.7	6.6

In order to approximate the temperature gradient in the rectifying section in the vicinity of the feed plate, a calculation will be made for several plates for fractionation between Cuts 8.

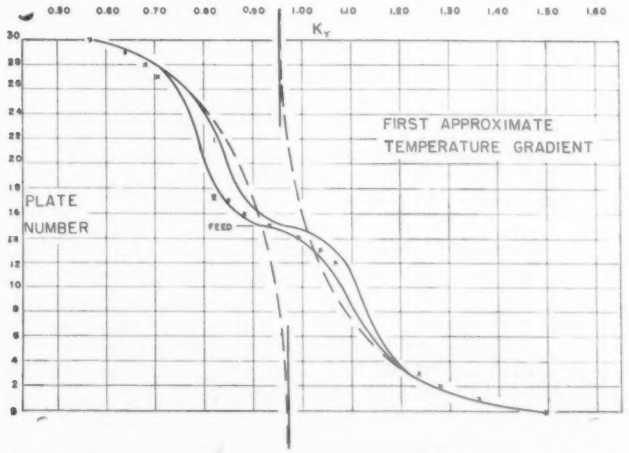

Fig. 2—Construction of First Approximate Curve of K for Reference Component vs. Plate Number. Crosses are check K_r values obtained by plate-to-plate calculation using compositions obtained in Table III through use of Curve 2 for simplified fractionation calculations

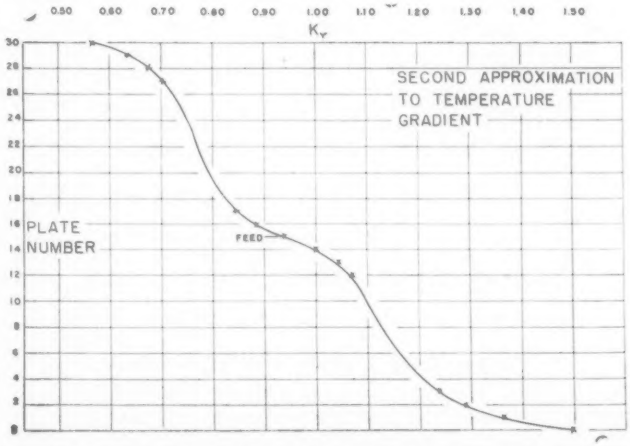

Fig. 3—Second Approximate K_r Curve. This curve has been drawn through the points indicated by crosses in Fig. 2. The crosses here are check points obtained as before

9, 10 and Cuts 1-7 taken as a single component with constant volatility. The average volatility of Cuts 1-7 is found by working back from the assumed feed plate temperature.

Cut	x_F	α	x_α	v_F	d	l_{F+1}	$l_{F+1\alpha}$	v_{F+1}	l_{F+2}
1–7	75.6	1.193	90.4	1760	508	1252	1498	1840	1332
8	10.0	0.680	6.8	132	...	132	90	110	110
9	7.8	0.490	3.8	74	...	74	36	44	44
10	6.6	0.330	2.2	43	...	43	14	17	17
	100.0		103.2	2009		1501	1638	2011	1505

$1/0.970 = 1.032$

$K_r = 0.917$

Cut	l_{F+2}	α	$l_{F+2\alpha}$
1–7	1332	1.193	1592
8	110	0.680	75
9	44	0.490	22
10	17	0.330	6
	1503		1695

$K_r = 0.887$

In the same fashion the temperature change below the feed plate may be approximated by fractionating between Cuts 1, 2, 3 and Cuts 4-10 taken as a single component.

Cut	x_F	α	$x_{F\alpha}$	l'_F	b	v'_{F-1}	v'_{F-1}/α	l'_{F-1}
1	1.8	3.70	6.7	36	...	36	10	13
2	3.3	2.33	7.7	66	...	66	28	36
3	5.5	1.70	9.4	110	...	110	65	83
4–10	89.4	0.888	79.4	1780	492	1288	1450	1860
	100.0		103.2	1992		1500	1553	1992

$K_r = 0.970$ $\qquad$ $K_r = 1.038$

Cut	l'_{F-1}	b	v'_{F-2}	α	v'_{F-2}/α
1	13	...	13	3.70	4
2	36	...	36	2.33	15
3	83	...	83	1.70	49
4–10	1860	492	1368	0.888	1540
	1992		1550		1608

$K_r = 1.070$

A smooth curve for K_r in both sections may now be obtained by drawing curves through these points and blending them with the asymptotic curves already drawn. This is curve 1 in Fig. 2. The distribution of Cut 4 may be then checked by using this curve as follows:

The values of $l_{25}/d = 3.64$ and $v'_2/b = 14.1$ for Cut 4 have already been obtained by plate-to-plate calculation. Starting with these values the calculation for Cut 4 may be carried from the top and bottom of the column toward the feed plate using the simplified calculation previously described. For example, for Cut 4 $l_{25}/d = 3.64$ and $(KV/L)_{27} = 1.383$. Then $l_{27}/d = 3.64 + 1/1.383 = 3.35$.

		Cut 4			
Plate	K_r	α	K	KV/L	l/d
28	.	.	.	.	3.64
27	0.737	1.40	1.031	1.383	3.35
26	0.764	...	1.070	1.435	3.03
25	0.785	...	1.100	1.475	2.73
24	0.802	.	1.122	1.505	2.48
23	0.817	1.39	1.138	1.524	2.28
22	0.829	...	1.152	1.546	2.12
21	0.839	...	1.167	1.562	2.00
20	0.847	...	1.180	1.580	1.90
19	0.856	...	1.190	1.595	1.82
18	0.870	...	1.210	1.622	1.74
17	0.887	...	1.232	1.651	1.66
16	0.917	...	1.275	1.709	1.56
15	0.970	...	1.350	1.810	1.41

		Cut 4			
Plate	K_r	α	K	L'/KV'	v'/b
2	.	.	.	.	14.1
3	1.220	1.37	1.672	0.795	19.0
4	1.195	.	1.639	0.811	24.6
5	1.174	1.38	1.621	0.819	31.3
6	1.156	...	1.598	0.832	38.8
7	1.144	...	1.580	0.840	47.4
8	1.132	...	1.564	0.849	57.0
9	1.122	...	1.550	0.857	67.7
10	1.114	...	1.540	0.863	79.5
11	1.105	...	1.527	0.872	92.2
12	1.090	...	1.505	0.883	105
13	1.070	...	1.479	0.900	118
14	1.038	...	1.432	0.927	128

l'_{15}/b is obtained by adding 1 to $(v'_{14}/b) = 128 + 1 = 129$. The value of l_{15}/d is calculated for the rectifying section liquid rate, simply for convenience. The distribution of Cut 4 is determined by matching the rectifying and stripping section calculations.

$$x_F = \frac{\left(\frac{l}{d}\right)_F \times d}{L} = \frac{\left(\frac{l'}{b}\right)_F \times b}{L'} \qquad (1)$$

$$\frac{d}{b} = \frac{\left(\frac{l'}{b}\right)_F \times \frac{L}{L'}}{\left(\frac{l}{d}\right)_F} \qquad (2)$$

$$\frac{f}{b} = 1 + \frac{\left(\frac{l'}{b}\right)_F \times \frac{L}{L'}}{\left(\frac{l}{d}\right)_F} \qquad (3)$$

$$\frac{100}{b} = 1 + \frac{129 \times \frac{1500}{1992}}{1.41} = 1 + 68.9 = 69.9 \qquad (4)$$

$$b = 1.43 \qquad (5)$$

Since with this feed plate temperature more of Cut 4 is being taken overhead than is desired, a feed plate $K_r = 0.925$ will be tried. The portion of the K curve near the feed plate that was calculated approximately is moved parallel to itself, and smooth curves drawn connecting this with the asymptotic curves previously used. This gives curve 2 in Fig. 2.

The calculation for Cut 4 is now repeated using Curve 2 and this time a value of 2.2 is obtained for the mols of Cut 4 in the bottoms. This is considered sufficiently close, and the calculation for the other distributed components is now carried out as shown in Table II.

This simplified plate-to-plate calculation need ordinarily be made only for the components of intermediate volatility, which are distributed. It is well to start with those components that are certain to be distributed, which in this case are Cuts 4, 5, and 6. In the rectifying section calculation it is evident that Cut 7 is the heaviest that will be present in the overhead in appreciable quantity because of the high value of l_{15}/d for Cut 7. No calculations for cuts heavier than 7 need then be made in the rectifying section. On the other hand, the lighter the component the more is the tendency as the feed plate is approached in the rectifying section to attain the condition $(l/d)\ (KV/L - 1) = 1$. This fact may be taken advantage of to calculate the feed plate concentration of the lightest cuts. The point at which this becomes permissible is readily determined. For example, suppose that Cut 4 had been assumed to have constant composition at plate 18, where the temperature curve is fairly flat. The calculation toward the feed plate would then have been as follows:

Plate	Cut 4 KV/L	l/d
18	1.541	1.85
17	1.570	1.82
16	1.676	1.68
15	1.725	1.55

The value of 1.55 thus obtained checks fairly well with 1.62 obtained by the complete calculation. Therefore the calculation for cuts lighter than 4 is carried out by obtaining l/d as $1/(KV/L - 1)$ at a point sufficiently far from the feed plate to have the K curve somewhat leveled out, and then proceeding to the feed plate as described above. This is also shown in Table II.

An analogous procedure is followed for the stripping section, with values of v'_{14}/b being obtained for Cuts 4 to 10. By adding 1 to those values l'_{15}/b is obtained.

The distribution of all the components may now be found by matching the results of the rectifying section calculation against those for the stripping section, in the same manner as the distribution of Cut 4 was obtained. This calculation leads to

TABLE II—Stepwise Calculation (Based on Curve 2, Figure 2)

$L = 1500$, $D = 508$, $V = 2008$ | $V/L = 1.340$ | $V' = 1500$, $B = 492$, $L' = 1992$ | $L'/V' = 1.328$ | $L'/L = 1.328$

RECTIFYING SECTION

Plate	Cut 6 K	Cut 6 KV/L	Cut 6 l/d	Cut 4 α	Cut 4 KV/L	Cut 4 l/d	Cut 5 α	Cut 5 KV/L	Cut 5 l/d	Cut 7 α	Cut 7 KV/L	Cut 7 l/d
28	.....	.....	8.45	....	.....	3.64	....	.....	5.54	....	.....	18.5
27	0.727	0.975	9.68	1.40	1.367	3.40	1.17	1.141	5.72	0.76	0.741	26.2
26	0.746	1.000	10.7	....	1.402	3.14	....	1.170	5.74	....	0.760	35.8
25	0.760	1.018	11.5	....	1.427	2.90	....	1.190	5.66	....	0.774	47.6
24	0.773	1.037	12.0	....	1.450	2.69	....	1.212	5.50	....	0.789	61.5
23	0.783	1.050	12.4	....	1.470	2.51	....	1.230	5.28	....	0.799	78.2
22	0.792	1.061	12.6	....	1.490	2.36	....	1.242	5.05	....	0.808	97.9
21	0.798	1.070	12.7	....	1.500	2.24	....	1.252	4.82	....	0.814	121
20	0.804	1.078	12.7	....	1.510	2.15	....	1.260	4.62	....	0.820	149
19	0.813	1.090	12.6	1.39	1.519	2.08	....	1.277	4.40	....	0.829	181
18	0.827	1.110	12.3	....	1.541	2.00	....	1.300	4.15	....	0.845	215
17	0.842	1.130	11.8	....	1.570	1.91	....	1.322	3.89	....	0.860	251
16	0.872	1.170	10.9	....	1.626	1.79	....	1.370	3.57	0.77	0.890	283
15	0.925	1.240	9.59	....	1.725	1.62	....	1.452	3.15	....	0.943	301

Plate	Cut 1 α	Cut 1 KV/L	Cut 1 l/d	Cut 2 α	Cut 2 KV/L	Cut 2 l/d	Cut 3 α	Cut 3 KV/L	Cut 3 l/d
18	3.75	4.16	0.316	2.38	2.64	0.609	1.70	1.89	1.12
17	....	4.24	0.310	....	2.69	0.597	....	1.92	1.10
16	....	4.39	0.296	....	2.79	0.572	....	1.99	1.05
15	....	4.65	0.278	....	2.96	0.530	....	2.11	0.972

STRIPPING SECTION

Plate	Cut 6 K	Cut 6 L'/KV'	Cut 6 v'/b	Cut 4 α	Cut 4 L'/KV'	Cut 4 v'/b	Cut 5 α	Cut 5 L'/KV'	Cut 5 v'/b	Cut 7 α	Cut 7 L'/KV'	Cut 7 v'/b
2	.....	.....	6.26	....	.....	14.1	....	.....	9.17	....	.....	3.48
3	1.220	1.090	6.65	1.37	0.796	18.9	1.16	0.940	10.8	0.78	1.400	3.20
4	1.186	1.120	6.83	....	0.819	24.2	....	0.965	12.2	....	1.440	2.92
5	1.160	1.147	6.82	1.38	0.830	30.3	....	0.988	13.4	....	1.470	2.67
6	1.140	1.167	6.70	....	0.845	37.1	....	1.006	14.3	....	1.497	2.45
7	1.122	1.183	6.50	....	0.857	44.4	....	1.021	15.0	....	1.520	2.27
8	1.108	1.200	6.25	....	0.869	52.2	....	1.033	15.5	....	1.540	2.12
9	1.095	1.214	5.96	....	0.879	60.6	....	1.048	15.8	....	1.558	2.00
10	1.072	1.239	5.63	....	0.898	68.7	....	1.068	15.8	....	1.589	1.89
11	1.067	1.247	5.31	....	0.904	77.1	....	1.072	15.7	....	1.598	1.81
12	1.047	1.270	4.97	....	0.920	85.0	....	1.095	15.3	....	1.630	1.72
13	1.025	1.297	4.61	....	0.940	91.7	....	1.118	14.6	....	1.662	1.64
14	0.993	1.340	4.19	....	0.970	95.5	....	1.155	13.5	....	1.720	1.54

Plate	Cut 8 α	Cut 8 KV/L	Cut 8 l/d	Cut 9 α	Cut 9 KV/L	Cut 9 l/d	Cut 10 α	Cut 10 KV/L	Cut 10 l/d
11	0.680	1.83	1.20	0.490	2.54	0.649	0.333	3.74	0.365
12	.....	1.87	1.18	.....	2.59	0.636	.....	3.81	0.358
13	.....	1.91	1.14	.....	2.64	0.619	.....	3.89	0.349
14	.....	1.97	1.09	.....	2.74	0.590	.....	4.02	0.335

a value for mols for feed plate liquid for each component and therefore feed plate composition. The results are shown in Table III.

It will be noted that the feed plate composition totals only to 95.3%. This indicates some error in the K_r curve. The K_r values are now checked by calculating from the new bottoms and overhead compositions and either way from the feed plate composition for several plates. These calculations are shown in Table IV. In making the rectifying section calculation upward from the feed plate the mols of light non-distributed components are obtained from the previous calculation in Table II. Any error from this should be unimportant, and the danger is avoided of serious error possible in calculating away from the feed-plate for a non-distributed component. A similar procedure is followed for heavy non-distributed components in the stripping section. These K_r points, shown as crosses, are compared with Curve 2, Fig. 2. The agreement is good enough to justify using the distribution already obtained as correct, but the calculation will be carried another step as a matter of interest.

TABLE III—Match at Feed Plate

Cut	v'_{14}/b	l'_{15}/b	l_{15}/d	d	b	l_{15}	l'_{15}	x_{15}
1	.....	.....	0.278	100.0	....	27.8	....	1.9
2	.....	.....	0.530	100.0	....	53.0	....	3.5
3	.....	.....	0.972	100.0	....	97.2	....	6.5
4	95.5	96.5	1.62	97.8	2.2	158.3	....	10.6
5	13.5	14.5	3.15	78.1	21.9	246.0	....	16.4
6	4.19	5.19	9.59	28.9	71.1	....	369.0	18.5
7	1.54	2.54	301	0.63	99.4	....	252.4	12.7
8	1.09	2.09	.....	.....	100.0	....	209.0	10.5
9	0.590	1.590	.....	.....	100.0	....	159.0	8.0
10	0.335	1.335	.....	.....	100.0	....	133.5	6.7
	.....	....	.....	505.4	494.6	....	....	95.3

Using the new calculated temperature points, a new curve for K_r is drawn in Fig. 3, and the step-wise calculation is repeated in Table V. A new distribution and new feed-plate composition are thus obtained in Table VI, and the curve is checked on the basis of these compositions. These check points are shown as crosses in Fig. 3. The results are summarized in Table VII.

It is evident that the values of K_r calculated on the basis of the final compositions check the values used in the corresponding step-wise calculation within the limit of error in reading the relative volatilities. The only possibility that the results could fail to be rigorously correct would be that the K curve drawn between the calculated points at top and bottom and those at the feed tray was in error. It hardly seems likely that this could be enough to make any appreciable difference. The calculation is still not altogether self-consistent, as is evident from the fact that the feed plate composition totals up to only 97.8%, but the error in the distribution of components resulting therefrom should be trifling.

The final calculations show 1.86 mols/hr. of Cut 4 in the bottoms rather than 2.0 as desired. This will be taken as sufficiently close. If, however, it were desired to adjust the cut point to hit 2.0 exactly it could be done easily enough by simply displacing slightly the whole temperature curve. The shape of this curve will not usually change much for small variations in cut point. In Fig. 4 are shown K curves for several different cut points for the conditions in the present problem. From this it appears that by multiplying the K value for a given cut point

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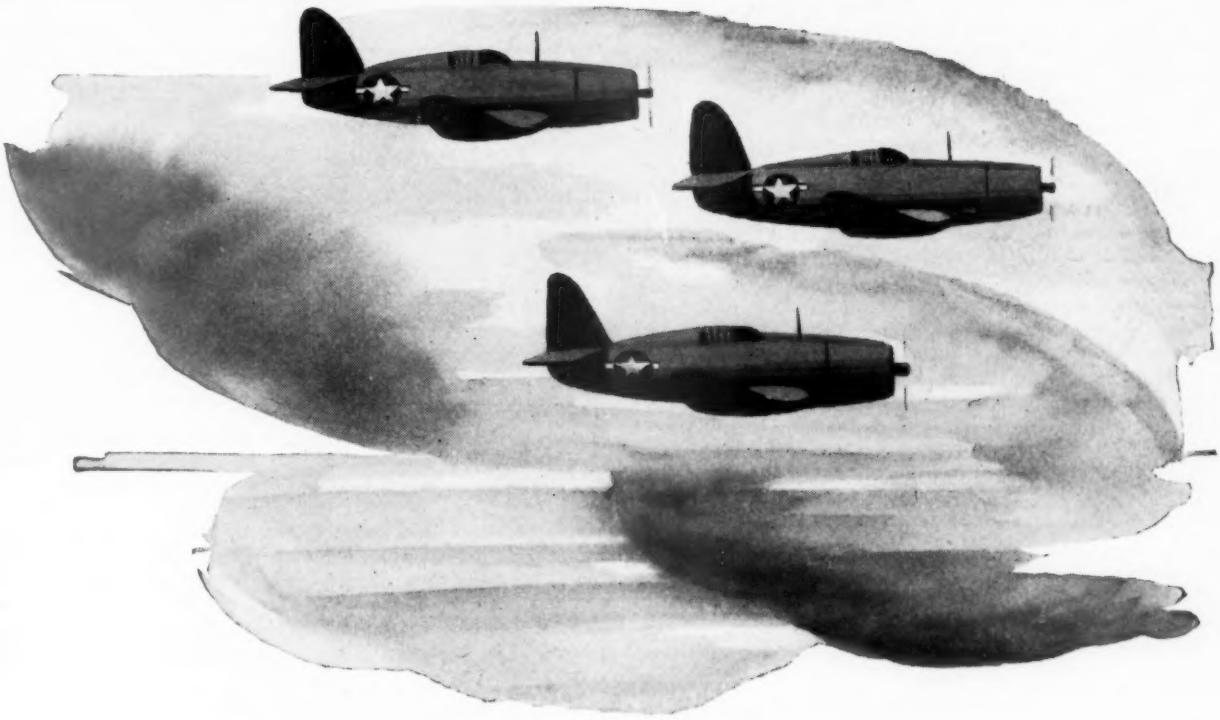

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by a certain factor a good approximation to the curve for a slightly different cut point may ordinarily be obtained. In Fig. 5 the distribution of the various components is shown as a function of cut point. It will often be helpful in studying the operation of a tower to prepare such curves.

General Discussion

The number of points that must be determined by usual plate-to-plate calculation to locate the K curve satisfactory is a matter of individual judgment. A study of K curves for different types of fractionation is helpful in developing such judgment.

The purpose of the preliminary calculation in the vicinity of the feed plate described in the example problem is to take account of the large temperature change often caused at the feed plate by the fractionation out of very heavy and very light components occasioned by the change in operating line. Fractionation among components of intermediate volatility is neglected in this procedure, which is designed primarily for a sloppy separation. This calculation should not be continued to where the fractionation out of the non-distributed components ceases to cause an important temperature change, as it will become meaningless. In case the non-distributed light components are negligible, no correction obviously need be made for them in the stripping section for the first K curve. Naturally the same applies in the rectifying section for non-distributed heavy components.

In some instances it will be possible to make a good preliminary estimate of feed tray composition from the assumed temperature, as for example where there are only two distributed components and they are present in fairly large amount on the feed tray. In such a case the shape of the first K curve near the feed tray will best be determined by the procedure used by Jenny[8]. The light and heavy non-distributed components are

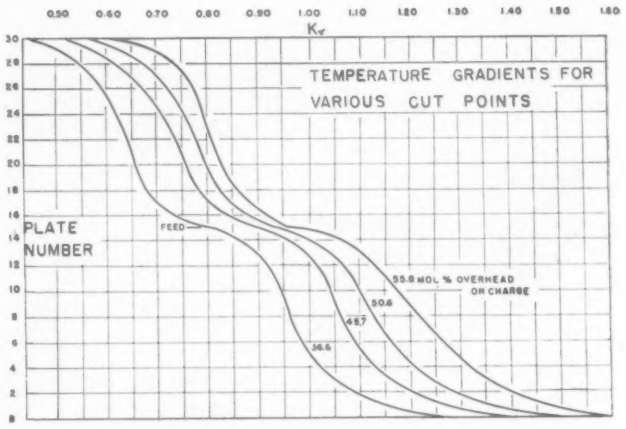

Fig. 4—K_r Curve as a Function of Cut Point. All conditions of the example problem except the cut point have been kept the same

TABLE IV—Check of Temperature Points at Top, Bottom, and Feed Plate

Cut	d	α	d/α	l_{30}	v_{29}	α	v_{29}/α	l_{29}	v_{28}	α	v_{28}/α	l_{28}	v_{27}	α	v_{27}/α	l_{27}	l_{27}/d
1	100.0	4.10	24.4	128.7	228.7	4.10	55.8	65.1	165.1	4.10	40.2	44.2	144.2	4.10	35.2	.....	.....
2	100.0	2.50	40.0	210.5	310.5	2.50	124.2	145.1	245.1	2.50	98.0	107.9	207.9	2.50	83.0	.....	.....
3	100.0	1.77	56.4	297.0	397.0	1.77	224.0	261.5	361.5	1.77	204.0	224.2	324.2	1.77	183.0	.....	.....
4	97.8	1.40	69.8	368.0	465.8	1.40	332.5	386.0	483.8	1.40	345.0	379.5	477.3	1.40	341.0	361.0	3.68
5	78.1	1.18	66.2	348.5	426.6	1.18	362.0	422.0	500.1	1.18	425.0	467.0	545.1	1.18	461.5	489.0	6.23
6	28.9	1.00	28.9	152.2	181.1	1.00	181.1	211.5	240.4	1.00	240.4	264.5	293.4	1.00	293.4	310.0	10.7
7	0.63	0.750	0.84	4.4	5.0	0.750	6.7	7.8	8.4	0.750	11.2	12.3	12.9	0.750	17.2	18.2	29.0
	505.4	.....	286.5	1509.3	2014.7	.....	1286.3	1499.0	2004.4	.....	1363.8	1499.6	2005.0	.....	1414.3	.....	.....

$(K_r)_{30} = 286.5/505.4 = 0.568$ $(K_r)_{29} = 1286.3/2014.7 = 0.639$ $(K_r)_{28} = 1363.8/2004.4 = 0.680$ $(K_r)_{27} = 1414.3/2005.0 = 0.705$

Cut	b	α	$b\alpha$	v'_R	l'_1	α	$l'_{1\alpha}$	v'_1	l'_2	α	$l'_{2\alpha}$	v'_2	l'_3	α	$l'_{3\alpha}$	v'_3	v'_3/b
4	2.2	1.37	3.0	13.3	15.5	1.37	21.2	21.6	23.8	1.37	32.6	31.4	33.6	1.37	46.0	42.7	19.4
5	21.9	1.16	25.4	115.0	136.9	1.16	158.6	162.0	183.9	1.16	213.0	205.5	227.4	1.16	263.8	246.5	11.3
6	71.1	1.00	71.1	322.0	393.1	1.00	393.1	401.0	472.1	1.00	472.1	455.0	526.1	1.00	526.1	489.0	6.86
7	99.4	0.790	78.6	356.0	455.4	0.790	360.0	368.0	467.4	0.790	370.0	356.5	455.9	0.790	360.0	334.0	3.36
8	100.0	0.690	69.0	313.0	413.0	0.690	285.0	291.0	391.0	0.690	270.0	260.0	360.0	0.690	248.5	230.5	.....
9	100.0	0.500	50.0	226.5	326.5	0.500	163.3	167.0	267.0	0.300	133.5	128.8	228.8	0.500	114.4	106.3	.....
10	100.0	0.342	34.2	155.0	255.0	0.342	87.4	89.2	189.2	0.342	64.7	62.4	162.4	0.342	55.5	51.5	.....
	494.6	.....	331.3	1500.8	1995.4	.....	1486.6	1499.8	1994.4	.....	1555.9	1499.6	1994.2	.....	1614.3	1500.5	.....

$(K_r)_R = 494.6/331.3 = 1.495$ $(K_r)_1 = 1995.4/1468.6 = 1.360$ $(K_r)_2 = 1994.4/1555.9 = 1.282$ $(K_r)_3 = 1994.2/1614.3 = 1.237$

Cut	x_{15}	l'_{15}	v'_{14}	α	v'_{14}/α	l'_{14}	v'_{13}	α	v'_{13}/α	l'_{12}	v'_{12}	α	v'_{12}/α
1	1.9	39.8	39.8	3.75	10.6	14.4	14.4	3.75	3.8	4.9	4.9	3.75	1.3
2	3.5	73.4	73.4	2.35	31.2	42.5	42.5	2.35	18.1	23.4	23.4	2.35	9.9
3	6.5	136.1	136.1	1.70	80.0	109.0	109.0	1.70	64.0	82.5	82.5	1.70	48.5
4	10.6	220.0	217.8	1.38	157.8	214.4	212.2	1.38	154.0	199.0	196.8	1.38	142.8
5	16.4	343.5	321.6	1.17	275.0	374.0	352.1	1.17	300.1	389.0	367.1	1.17	314.0
6	18.5	386.5	315.4	1.00	315.4	429.0	357.9	1.00	357.9	461.0	389.9	1.00	389.9
7	12.7	266.0	166.6	0.770	214.0	291.0	191.6	0.770	249.0	322.0	222.6	0.770	289.0
8	10.5	220.0	°109.0	0.680	160.2	218.0	°114.0	0.680	167.7	216.0	°118.0	0.680	173.5
9	8.0	167.7	° 59.0	0.490	120.2	163.8	° 61.9	0.490	126.0	162.7	° 63.6	0.490	130.0
10	6.7	140.2	° 33.5	0.330	101.6	138.2	° 34.9	0.330	105.8	136.2	° 35.8	0.330	108.7
	95.3	1993.2	1472.2		1466.0	1994.3	1490.5		1546.4	1996.7	1504.6		1607.6

$(K_r)_{14} = 1466.0/1472.2 = 0.994$ $(K_r)_{13} = 1546.4/1490.5 = 1.037$ $(K_r)_{12} = 1607.6/1504.6 = 1.067$

Cut	x_{15}	α	$x_{15}\alpha$	v_{15}	l_{16}	α	$l_{16\alpha}$	v_{16}	l_{17}	α	$l_{17\alpha}$
1	1.9	3.75	7.1	140.1	° 29.6	3.75	111.1	133.5	° 31.0	3.75	116.2
2	3.5	2.35	8.2	162.0	° 57.2	2.35	134.7	161 8	° 59.7	2.35	140.5
3	6.5	1.70	11.0	217.0	°105.0	1.70	178.7	214.2	°110.0	1.70	187.0
4	10.6	1.38	14.6	288.0	190.2	1.38	262.5	315.0	217.2	1.38	299.5
5	16.4	1.17	19.2	379.0	300.9	1.17	352.0	422.0	343.9	1.17	402.0
6	18.5	1.00	18.5	365.0	336.1	1.00	336.1	404.0	375.1	1.00	375.1
7	12.7	0.770	9.8	193.5	192.9	0.770	148.5	178.2	177.6	0.770	137.0
8	10.5	0.680	7.2	142.2	142.2	0.680	96.9	116.2	116.2	0.680	79.0
9	8.0	0.490	3.9	77.0	77.0	0.490	37.7	45.2	45.2	0.490	22.2
10	6.7	0.330	2.3	45.6	45.6	0.330	15.1	18.1	18.1	0.330	6.0
	95.3		101.8	2009.4	1476.7		1673.3	2008.2	1494.0		1764.5

$(K_r)_{15} = 95.3/101.8 = 0.935$ $(K_r)_{16} = 1476.7/1673.3 = 0.882$ $(K_r)_{17} = 1494.0/1764.5 = 0.847$

°Taken from previous calculation.

TABLE V—Stepwise Calculation (Based on Curve in Figure 3)

$L = 1500$, $D = 505$, $V = 2005$ | $V/L = 1.340$ | $V' = 1500$, $B = 495$, $L = 1995$ | $L'/V' = 1.330$ | $L'/L = 1.330$

RECTIFYING SECTION

	Cut 6			Cut 5			Cut 4			Cut 7		
Plate	K	KV/L	l/d	α	KV/L	l/d	α	KV/L	l/d	α	KV/L	l/d
27	.....	.....	10.7	.....	.....	6.23	.....	.....	3.68	.....	.....	29.0
26	0.724	0.970	12.0	1.17	1.153	6.34	1.40	1.358	3.44	0.76	0.738	40.6
25	0.740	0.991	13.1	.....	1.160	6.32	.....	1.389	3.20	.....	0.755	55.1
24	0.752	1.008	14.0	.....	1.180	6.20	.....	1.410	2.98	.....	0.766	73.2
23	0.763	1.022	14.7	.....	1.198	6.01	.....	1.430	2.78	.....	0.778	95.4
22	0.772	1.034	15.2	.....	1.211	5.74	.....	1.450	2.61	.....	0.787	122
21	0.782	1.048	15.5	.....	1.227	5.50	.....	1.467	2.46	.....	0.796	154
20	0.793	1.062	15.5	.....	1.242	5.23	.....	1.488	2.32	.....	0.809	191
19	0.805	1.079	15.3	.....	1.262	4.94	.....	1.510	2.20	.....	0.820	234
18	0.825	1.107	14.8	.....	1.292	4.60	1.39	1.539	2.08	.....	0.841	279
17	0.847	1.136	13.9	.....	1.330	4.21	.....	1.580	1.95	.....	0.864	324
16	0.882	1.182	12.6	.....	1.383	3.77	.....	1.642	1.80	0.77	0.900	362
15	0.935	1.252	10.8	.....	1.467	3.26	.....	1.740	1.61	.....	0.953	381

	Cut 3			Cut 2			Cut 1		
Plate	α	KV/L	l/d	α	KV/L	l/d	α	KV/L	l/d
18	1.70	1.88	1.14	2.38	2.63	0.613	3.75	4.15	0.317
17	.....	1.93	1.11	.....	2.70	0.597	.....	4.26	0.309
16	.....	2.01	1.05	.....	2.81	0.568	.....	4.46	0.293
15	.....	2.13	0.962	.....	2.98	0.525	.....	4.70	0.275

STRIPPING SECTION

	Cut 6			Cut 5			Cut 4			Cut 7		
Plate	K	L'/KV'	v'/b	α	L'/KV'	v'/b	α	L'/KV'	v'/b	α	L'/KV'	v'/b
3	.....	.....	6.86	.....	.....	11.3	.....	.....	19.4	.....	.....	3.36
4	1.206	1.102	7.12	1.17	0.943	13.0	1.37	0.805	25.4	0.78	1.412	3.09
5	1.184	1.121	7.24	.....	0.960	14.6	.....	0.820	32.2	.....	1.440	2.84
6	1.164	1.140	7.22	.....	0.975	16.0	1.38	0.827	40.1	.....	1.461	2.63
7	1.145	1.160	7.09	.....	0.991	17.1	.....	0.842	48.9	.....	1.489	2.44
8	1.129	1.179	6.85	.....	1.009	18.0	.....	0.855	58.4	.....	1.510	2.28
9	1.113	1.192	6.57	.....	1.020	18.6	.....	0.865	68.9	.....	1.530	2.14
10	1.098	1.211	6.25	.....	1.038	18.9	.....	0.880	79.5	.....	1.555	2.02
11	1.085	1.237	5.85	.....	1.057	19.0	.....	0.896	89.9	.....	1.586	1.90
12	1.067	1.248	5.49	.....	1.068	18.7	.....	0.905	100.0	.....	1.600	1.81
13	1.037	1.283	5.05	.....	1.098	17.9	.....	0.932	108	.....	1.648	1.71
14	0.994	1.339	4.51	.....	1.142	16.5	.....	0.971	112	.....	1.718	1.58

	Cut 8			Cut 9			Cut 10		
Plate	α	KV/L	l/d	α	KV/L	l/d	α	KV/L	l/d
11	0.680	1.82	1.22	0.490	2.52	0.658	0.333	3.71	0.369
12	.....	1.83	1.21	.....	2.54	0.653	.....	3.74	0.365
13	.....	1.89	1.17	.....	2.62	0.631	.....	3.85	0.354
14	.....	1.96	1.11	.....	2.73	0.598	.....	4.01	0.337

assumed to have constant composition, and the ratio of the two distributed components is found from the assumed feed tray temperature. Plate-to-plate calculations are then made either way from the feed tray on the basis of this composition.

When two components constitute much the greater part of the liquid in most of a tower, as in the case in an iso-butane or iso-pentane tower, an $x - y$ diagram may be more useful than K curve.

Variation in Molal Overflow

In cases where changes in reflux within a section of a tower are significant they may readily be taken into account in calculating KV/L and L'/KV'. It should be remembered that V and L represent the liquid and vapor leaving the plate in question. It will often be helpful to prepare a plot of V/L (or L'/V') or perhaps of KV/L (or L'/KV') as a function of plate number[6]. The trends in overflow change established at the ends of the column and at the feed plate will thus serve to establish overflow rate throughout the tower.

II. Calculation of Number of Theoretical Plates for a Separation Between Two Key Components in an Ideal System

Suppose that the reflux ratio and approximate number of plates for a given separation have been determined from applying, say, the Brown and Martin[1] correlation in conjunction with Colburn's method of minimum reflux[4] and the Fenske-Underwood [7,13] equation for minimum plates. The feed plate location is estimated and a curve drawn in the same fashion as was Curve 1, Fig. 2. The fractionation of the key components is then checked using this curve. The results of this calculation will make it evident whether more or less plates will be required in either section, and whether a change in feed plate temperature would be advisable.

For a change in feed plate temperature only, the curve is shifted just as the shift was made from Curve 1 to Curve 2, Fig. 2. In case the number of plates is altered the shape of the curve at the top or bottom and the feed plate is kept the same and a new curve sketched in using the new number of plates. This whole procedure is very simple and rapid. It should be kept in mind that the more plates there are in a section the farther the actual curve will tend to follow that sketched in asymptotic to the temperature of constant composition.

After a curve giving satisfactory fractionation for the key components has been obtained the distribution of the other components and the feed plate composition are found and the temperature curve checked just as before until satisfactory agree-

TABLE VI—Match at Feed Plate

Cut	v'_{14}/b	l'_{15}/b	l_{15}/d	b	d	l_{15}	l'_{15}	$x_{L_{15}}$
1	.....	.....	0.275	.....	100.0	27.5	.....	1.8
2	.....	.....	0.525	.....	100.0	52.5	.....	3.5
3	.....	.....	0.962	.....	100.0	96.2	.....	6.4
4	112	113	1.61	1.86	98.1	158.0	.....	10.5
5	16.5	17.5	3.26	19.9	80.1	261.0	.....	17.4
6	4.51	5.51	10.8	72.2	27.8	.....	398.0	20.0
7	1.58	2.58	381	99.5	0.51	.....	257.0	12.9
8	1.11	2.11	.....	100.0	.....	.....	211.0	10.6
9	0.598	1.598	.....	100.0	.....	.....	159.8	8.0
10	0.337	1.337	.....	100.0	.....	.....	133.7	6.7
	.....	.....	.....	493.5	506.5	.....	.....	97.8

TABLE VII—Summary of Assumed and Calculated Compositions and K_r Values

Cut	Split: Assumed d	Assumed b	First* Calculation d	First* Calculation b	Second † Calculation d	Second † Calculation b	Plate	K_r: Assumed Curve 2, Fig. 2	K_r: First Calculation Crosses, Fig. 2	K_r: Second Calculation Crosses, Fig. 3
1	100.0	....	100.0	....	100.0	....	30	0.575	0.568	0.566
2	100.0	....	100.0	....	100.0	....	29	0.656	0.639	0.637
3	100.0	....	100.0	....	100.0	....	28	0.764	0.680	0.678
4	98.0	2.0	97.8	2.2	98.1	1.86	27	0.727	0.705	0.701
5	65.0	35.0	78.1	21.9	80.1	19.9	17	0.842	0.847	0.848
6	40.0	60.0	28.9	71.1	27.8	72.2	16	0.872	0.882	0.887
7	5.0	95.0	0.63	99.4	0.51	99.5	15	0.925	0.935	0.941
8	....	100.0	.....	100.0	....	100.0	14	0.993	0.994	1.002
9	....	100.0	.....	100.0	....	100.0	13	1.025	1.037	1.044
10	....	100.0	.....	100.0	....	100.0	12	1.047	1.067	1.072
							3	1.220	1.237	1.240
	508.0	492.0	505.4	494.6	506.5	493.5	2	1.262	1.282	1.290
							1	1.342	1.360	1.363
							B	1.487	1.495	1.499

*First calculated values obtained using temperature gradient determined by assumed split, Curve 2, Figure 2.
†Second calculated values obtained using temperature gradient determined by first calculated split, curve Figure 3.

ment is obtained. An alteration in the number of plates may be necessary as the curve is corrected.

III. Extension to Non-Ideal Systems

The approach to fractionation problems outlined in this paper for ideal systems may also be applied with success to a certain type of non-ideal system important in azeotropic and extractive distillation. Suppose that the multicomponent charge to be fractionated consisted of several classes of compounds such that the same activity coefficient (Raoult's Law deviation factor) could be applied to every member of the same class. Then some one component could be selected for reference both for ideal volatility and for activity. The relative activity of every component in the same class with the reference component would be one, and that for a member of another class would be known from the equilibrium data as a function of composition and temperature.

In the calculation, in addition to the K curve for the reference component, there is also sketched in as a function of plate number for each class a curve of relative activity of that class to the class containing the reference component. The K for any component on any plate is then the product of its own ideal volatility relative to the reference component times the ratio of activity coefficients of the class of the given component to that of the reference component times the K for the reference component on that plate.

This of course introduces added complication into the calculations, but this would be no less true in the straightforward plate-to-plate computation. In such experience as the author has had with non-ideal systems, the change in activity coefficient ratio with composition is not sharp enough to necessitate an undue amount of trial-and-error manipulation, and the results have been quite encouraging.

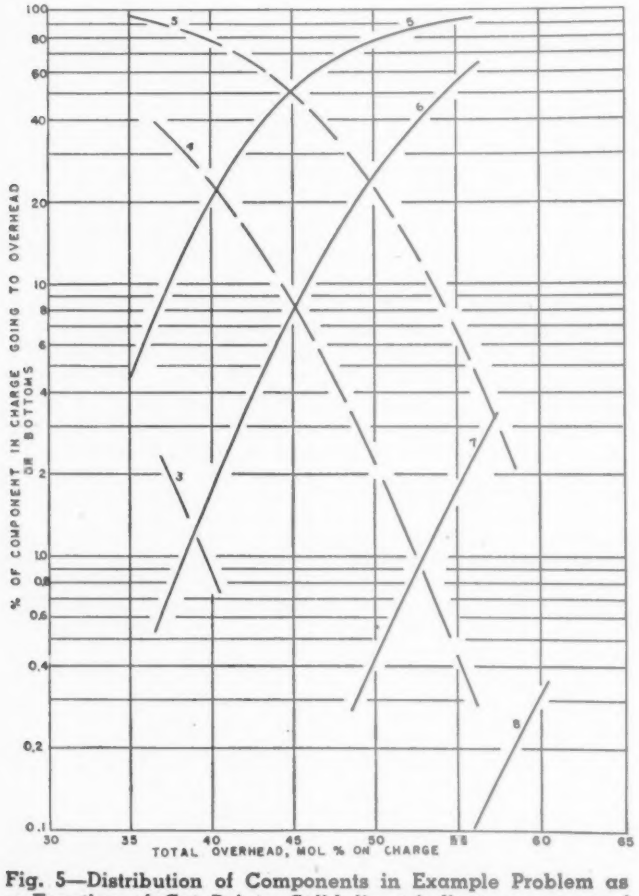

Fig. 5—Distribution of Components in Example Problem as a Function of Cut Point. Solid lines indicate per cent of component in charge going to overhead; dashed lines show per cent going to bottoms

ACKNOWLEDGMENT

Grateful thanks are due to H. G. Drickamer and J. E. Kasch for assistance with the calculations and for many helpful suggestions. The author also thanks the Pan American Refining Corporation, particularly F. J. Smith of the Chemical Engineering Division, for assistance and encouragement in matters pertaining to the preparation and presentation of this paper.

NOMENCLATURE

L = total mols of liquid per hour
V = total mols of vapor per hour
l = mols per hour of individual component in liquid stream
v = mols per hour of individual component in vapor stream
A ' with these quantities indicates they pertain to the stripping section; otherwise they pertain to the rectifying section.
y = mol per cent of individual component in vapor stream
x = mol per cent of individual component in liquid stream
K = equilibrium constant = y/x
D = total mols net overhead per hour
B = total mols bottoms per hour
d = mols net overhead of individual component per hour
b = mols bottoms of individual component per hour
f = mols of individual component in charge stream per hour
α = K/K_r
Σ = summation of quantity for all components

Subscripts:

$_r$ = reference component, Cut 6 in problem
$_B$ = reboiler
$_F$ = feed plate
$_{F+1}$ = plate above feed plate, etc.
Numbers refers to plates.

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Dehydration of Furnace Oil With Activated Alumina*

IT IS often desirable to remove the last traces of moisture from gasoline and furnace oil for several reasons. Some authorities attribute the internal corrosion of products pipe lines as being caused by the presence of free water. If all water is prevented from entering the pipe line, no corrosion will result unless a sour product is being carried. The same problem is attacked by the use of water soluble inhibitors, with attendant efforts to reduce the quantity of free water entering the line to the barest minimum. Other authorities on the subject make use of substances sparingly soluble in both the product and water, and thus inhibit both phases. The literature is exceedingly meager on the subject of dehydration as a preventative of corrosion.

From an entirely different angle, it is of paramount importance to market a furnace oil that is not only entirely devoid of free or entrained moisture at the time of sale, but will also remain so in spite of temperature changes rendering the water in true solution less soluble. The objections to the presence of moisture in furnace oil are readily apparent. A cloudy or foggy product is not acceptable to consumers. The separation of moisture on the delivery line between the storage tank and the user's furnace burner may form ice and clog screens. Such a result is aggravating and a nuisance.

During certain seasons of the year when the temperature is subject to wide fluctuations, a tank of furnace oil may be on hand at a terminal at, say, 50°F. The ordinary visible examination shows no trace of cloud or moisture. An aliquot is loaded into a transport and hauled to a bulk station storage plant or direct to an ultimate consumer. En route, the temperature drops to 30°F. If the furnace oil was saturated with moisture at 50°F., some water will drop out with the falling temperature and at 30°F. will form ice. The result is a cloudy product containing ice crystals and a vigorous complaint from the customer.

Such a problem as outlined above is apt to confront many products pipe lines. Since the solubility of water in furnace oil is exceedingly low even at higher temperature, the presence of even very small amounts of moisture in the pipe are sufficient to saturate the oil. Indeed, it is quite probable that much of the furnace oil is water saturated prior to tendering to the pipe line. The only solution to the problem is the removal of sufficient moisture from the furnace oil so that free water cannot separate regardless of temperature; in other words, a nearly bone dry product.

It is quite apparent from the above that methods must be available for determining very minute amounts of water in furnace oil. A figure must be set above which the moisture content cannot be tolerated. The procedure outlined by Smith and Bryant has proved quite satisfactory. This method was devised for the determination of minute quantities of water in various organic compounds. In the case of a substance such as furnace oil consisting mainly of saturated hydrocarbons, the method is even more accurate than claimed by the originators, since a relatively large sample can be utilized and the presence of interfering substances is of little concern.

The analytical procedure is based upon the liberation of acetic acid by the reaction of the water in the sample with acetyl chloride in the presence of pyridine and the subsequent titration of the acetic acid with standard sodium hydroxide solution. Careful technique and the use of dehydrated reagents are essential. As little as .0002 per cent moisture in furnace oil may be determined.

A practical method is described for the removal of sufficient moisture from furnace oil so that free water cannot separate from the oil even at wide temperature changes. The water is removed by passing the oil through beds of activated alumina. Twin absorbers are used, one being regenerated while the other is in use. Regeneration is by steam under a relatively high vacuum. The method was developed by a large pipeline company.

Another method which is entirely qualitative in scope makes use of tendency for anhydrous copper sulfate to reveal the presence of even traces of moisture by the formation of the characteristic blue color of the cupric iron. A small quantity of the anhydrous copper sulfate is added to a sample of furnace oil in a four-ounce bottle. If no blue color is noted, the furnace oil is substantially moisture-free and not likely to form objectionable cloud regardless of falling temperatures.

Derr and Williams have discussed the drying of numerous organic solvents as well as gasoline with activated alumina. Among these may be mentioned ethyl and butyl acetates, pyridine, benzene, and toluene. There are numerous drying agents in commercial use. Among these are calcium chloride, silica gels, phosphorus pentoxide, activated alumina, activated clays and bauxite, and others. This article deals with the use of activated alumina, as its use appeared desirable because of certain inherent characteristics such as high absorptive capacity, ease of handling, availability, and ease of regeneration.

The absorbers consist of two vertical tanks 6 feet high and 2½ feet in diameter connected in parallel. Only one tank is used at a time, the other being reactivated during the interval. The oil stream enters at the top of the tank and flows down through the bed of activated alumina. By-pass piping is provided so that both tanks may be taken from service, if necessary. Provision was made for a normal oil flow of 750 gallons per minute, with each tank capable of drying 100,000 gallons of furnace oil saturated with moisture at 75°F. The actual moisture content of the oil was calculated as .0048 per cent at saturation. Activated alumina will absorb approximately 7.4 per cent water by weight before it begins to pass any moisture.

From the above, it is apparent that approximately 550 pounds of 4-8 mesh activated alumina will be required to dehydrate 100,000 gallons of furnace oil prior to regeneration. This quantity determined the size of the tanks involved. Extra precautions should be taken to prevent the entry of any free water into the tanks along with the furnace oil. Such free water in any appreciable quantity will, of course, completely saturate the drying agent and compel reactivation at once. The above described design allows a maximum flow of approximately 70 gallons per hour per pound of alumina. This, of course, is subject to variation by changing the discharge quantity of the pump.

There are several means available for reactivating alumina. When drying is carried out at oil refineries, hot waste flue gases may be passed through the bed. Such a procedure presents decided disadvantages, mainly the danger of fire. An alternative method of reactivation consists of using an inert gas, such as methane or nitrogen. The gas is introduced into the system and then circulated through a pre-heater, the alumina bed and finally to a condenser. The moisture is removed in the condenser, and the reheating of the inert gas further dries the alumina.

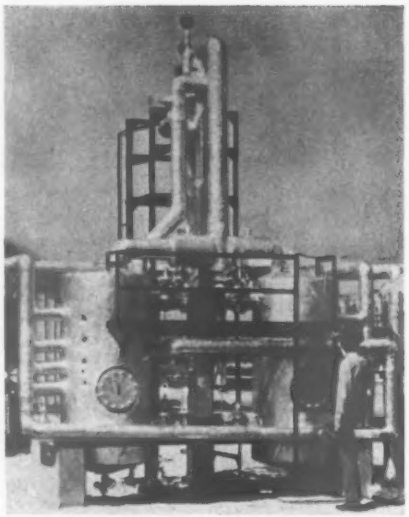
Because of the difficulties concomitant with the use of an inert gas and the unavailability of waste flue gas, in this case it was decided to make use of available 90-pound steam and relatively high vacuum. If a 450°F. temperature is required to flash the water from the alumina, a 238°F. heat head is required, assuming the boiling point of water as 212°F. at the location in question. This much heat head is required because the oil coating on the alumina greatly increases its surface tension. The temperature of steam at 80 pounds gauge pressure dry and saturated is 324°F. so that for a 238°F. heat head, the vacuum maintained would have to correspond to a temperature of 86°F. or 1.25 inches mercury absolute pressure.

Maintaining this absolute pressure eliminated the necessity of installing a superheater in connection with the boiler

*From the Merco Nordstrom Valve Co.'s publication, The Flow Line, March-April, 1944.

available for this service in conjunction with heating. It is calculated from the physical properties of the activated alumina that one square foot of heating surface is required for each 8 pounds of alumina or in this case a total of approximately 200 feet of standard one-inch pipe. This was incorporated in the tanks so as to be buried in the bed of alumina.

The dehydrating cycle is as follows: Furnace oil is led through the respective chamber until periodic control tests reveal the presence of traces of moisture in the effluent. The tank is switched, and steam fed into the coils while the tank is still full of oil. The presence of the oil greatly reduces the time necessary to heat the alumina because of the very low heat conductivity of the latter. The oil is then drained and a vacuum pulled. Approximately 26 inches of mercury vacuum is held for about two hours, steam being continuously fed through the coils. A shorter regeneration time could be secured with a more adequate steam supply and faster circulation of cooling water in the two stage ejector and condensers. In this case, the two-hour period is quite satisfactory as each tank will handle at least eight hours loading of furnace oil with the pumping facilities available.



Unit for the dehydration of furnace oil by passing it through a bed of activated alumina

The use of activated alumina dehydrators produces a practically "bone dry" furnace oil when ordinary methods of routine checks on operation are maintained. Complaints emanating from delivery of a product, which, although free from cloud and entrained moisture as it left the terminal, became objectionable due to the precipitation of soluble moisture with lowering of atmospheric temperatures. Bone dry oil will not precipitate moisture regardless of temperature changes.

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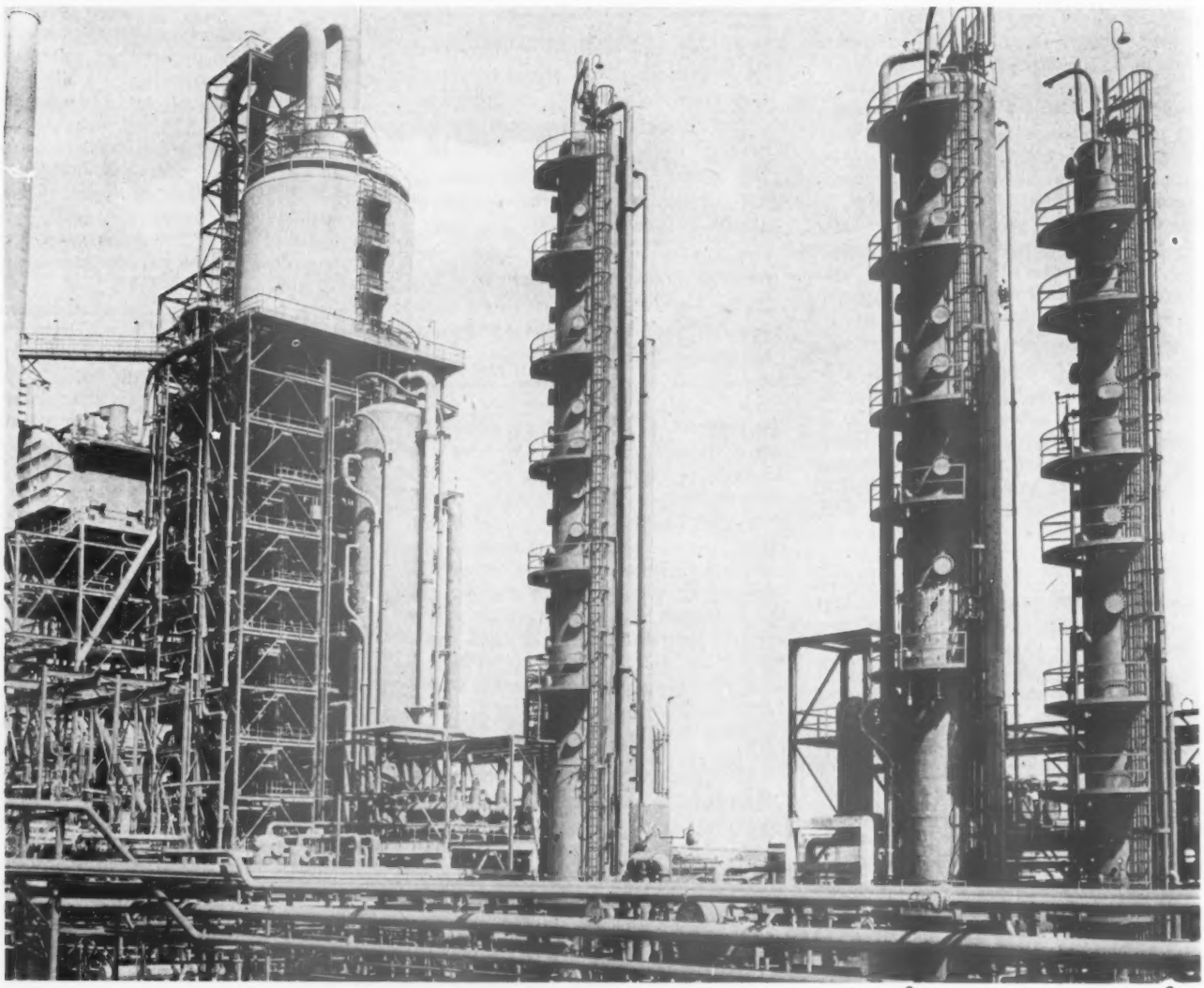
Design Changes in Wartime Refineries Save Critical Materials



Wartime refinery construction has necessitated many changes in design and construction practices to save critical materials, as illustrated in the above view of a Standard Oil Co. of New Jersey refinery. Fractionating tower platforms used by operators have been eliminated in some cases by relocating operating controls at lower levels, or by using remote control. Maintenance platforms have been spaced further apart and reduced in width where possible. Infrequently used access stairs have given way to ladders. Full details on wartime refinery construction were given in an article in the Nov. 1, 1944, issue of NPN's Technical Section, pgs. R-745—748

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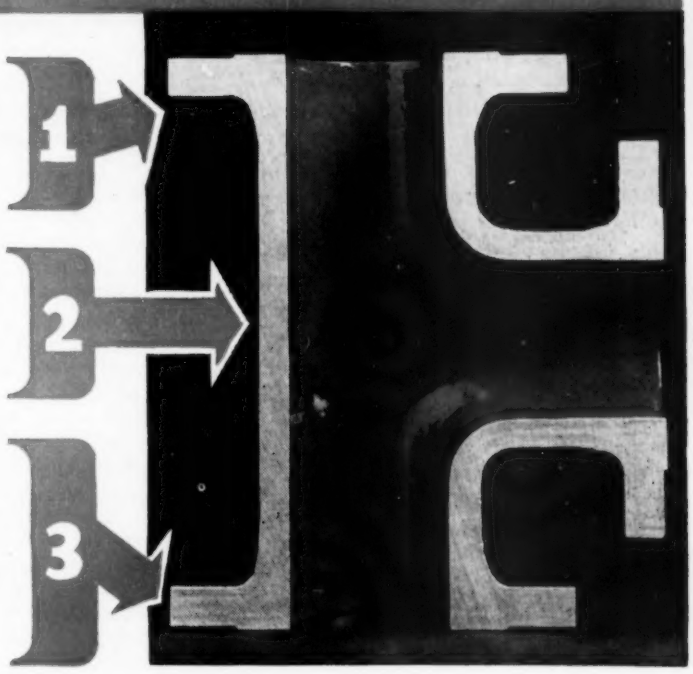

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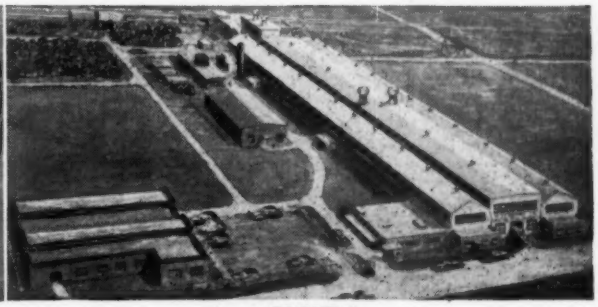

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Postwar Internal Combustion Engines And Their Fuels*

By T. B. Rendel**

The various types of internal combustion engines are classified, from tractor engines to jet propulsion and including both spark and compression ignition. Fuel requirements are discussed in the light of possible postwar developments in engines and of the requirements of economic refinery operations.

Some problems are presented for co-operative research between the automotive and petroleum industries, the solving of which will promote further advances in both engines and fuels. Foremost among these is the development of methods for interpreting laboratory ratings of octane numbers in terms of actual engine performance.

"The time has come," the Chairman said,
"To talk of many things—
Of cars and planes and Diesel Fuels;
Of catalysts and 'pings'
And why a plane gets vapor lock
And whether 'jets' have wings."

(*With apologies to Lewis Carroll and other parodists*)

Introduction

When I first undertook to give this paper, I did so with the idea that in collecting the necessary data I would to some extent re-educate myself technically in the latest developments in the art of fitting fuels to internal combustion engines after two years' diplomatic education in this field for the British Air Commission.

However, I soon became appalled at the amount of crystal gazing on future fuel requirements which had already been done, and, in view of the experience of crystal-gazers in all fields of endeavor over the past few years, I thought it might be more interesting if we were to review broadly the whole field of internal combustion engines and their fuel requirements, together with the field of refinery operations as they will exist for the next few years.

Following this we might usefully turn our attention to some of the more profitable problems which both industries will have to settle cooperatively, in the hope that some of the crystal-gazers' prophecies may be justified.

I am well aware that to cover such a huge field in detail will consume a great deal of time and I shall, therefore, ask your indulgence if I appear to glide over some of the points rather hurriedly. Furthermore, if I should at times indulge in a spot of crystal gazing in regard to the types of internal combustion engines expected in the next few years or the amount of fuel which may be available, I beg that you will take these figures with the necessary grain of salt. So many different economic and political factors can enter into the picture which will completely alter these values, and I have only used them as illustrations, or shall we say as spice in what might otherwise become a verbose but superficial exercise in classification.

Part I—Types of Internal Combustion Engines and Their Fuel Requirements

Classification of Internal Combustion Engines

Heat engines, that is prime movers which convert the chemical energy of fuel, be it solids, liquids or gases, into mechanical work, can be divided into two classes, external combustion and internal combustion.

In an internal combustion engine, there are two main problems; (1) to introduce the fuel and air in a tasty fashion with the minimum possible expenditure of energy and (2) to digest this fuel and air in such a way that we extract the greatest possible amount of heat energy available in the time at our disposal and in such a way that the waste products of combustion are most readily eliminated. The point at which we can most conveniently make the first separation in an analysis of fuel requirements is at the point of ignition, and divide internal combustion engines into two main divisions, the spark ignition engine and the so-called Diesel or compression ignition engine.

In the first class, fuel and air are usually mixed and conditioned during their introduction into the cylinder and ignited by some auxiliary means, usually a high tension electric spark. In the second class the fuel is ignited by the temperature of the hot air charge which has been previously drawn into the cylinder and heated to ignite the fuel by compression.

In 1941, in the U. S. alone, approximately 2½ billion horsepower was developed from spark ignition engine sources. The compression ignition engine field is not yet as large, but in 1941 produced some 12 million horsepower, of which 25% was for marine use, 50% stationary or semi-mobile power generation and 25% for trucks and tractors and railway engines.

Fig. 1 shows the classification which I have found the most useful basis from which to discuss the fuel requirements of the individual types.

In this classification discussion I have, it would appear, left out that newest form of development which now arouses considerable interest among the engineering fraternity, the internal combustion turbine. Pedantically speaking, I am inclined to think that this is a misnomer, and that the internal combustion turbine is really an external combustion turbine, but a turbine which uses the products of combustion directly, rather than through a medium such as water vapor. On the other hand, its problems are similar to those of the compression ignition engine with a separate combustion chamber, and I propose for the purposes of this paper, therefore, to consider its fuel requirements in the latter class though subsequent research may disprove this.

Spark Ignition Engine Fuel Requirements—Airplane Type

As would be expected, the fuel problems of the large size airplane engine (a spark ignition engine developing approximately 0.5 to 0.9 HP per cu. in. of cylinder displacement), have received a great deal of attention during the past few years, and as mentioned above can be conveniently divided into two main parts, introduction and "digestion".

As to the first part, if we are to introduce the fuel into the multitude of combustion chambers of a modern aero engine as a reasonably even mixture of fuel and air, we require a fuel of relatively low boiling range, certainly not above 300° F. for 90% distilled. Some latitude, though how much is not certain, might be allowed if we injected the fuel into each cylinder individually. Bearing in mind the difficulty of obtaining a homogeneous charge at the end of the compression stroke in the time and space available and the wide variation in temperature conditions under which this type of engine is employed, not much latitude can be expected in this direction. However, by making use of the inherent air swirl, particularly of sleeve valve engines, it should be possible to obtain some measure of stratification and thus work with a weaker mixture strength, and this, I think, is where the use of individual cylinder injection will score.

For the second problem, if the fuel is to be burned smoothly at the high charge densities and high compression ratios which must be used in this particular application, it also requires a fuel of very good anti-detonation characteristics (commonly measured in terms of octane number), since the destructive effect of detonation in this type of operation is such that it must be avoided at all costs if serious consequences directly affecting the safety of the operation are to be avoided. What can be

*Presented before Metropolitan Section, Society of Automotive Engineers, New York, Dec. 14, 1944.

**Assistant to the Vice President in Charge of Manufacturing, Shell Oil Co., Inc., New York.

done by way of increased anti-detonation characteristics is graphically illustrated in Fig. 2. This shows the average increase in horsepower and decrease in specific fuel consumption over the years and follows generally the rise in octane number of the fuel available.

Now as we increase compression ratio and boost pressure to utilize to the full the increased anti-knock potentialities of our fuels, we are liable to run into a new danger, that of preignition, i.e. actual ignition of the fuel air charge before the passage of the spark. From the viewpoint of rapid and serious damage to the engine, this danger is a far more serious one than the possible onset of detonation. With low octane fuels preignition was often the sequel to persistent heavy detonation, but with present outputs, particularly in engines with somewhat fouled combustion chambers preignition may be initiated without any preliminary detonation.

So long as compression ratios and maximum pressures are maintained within certain limits not yet accurately defined, in my personal opinion the danger from preignition is not yet sufficiently serious to warrant a clause in fuel specifications limiting its quality in this respect. It may, however, become a serious danger if advantage is taken of higher octane fuels to use high compression ratio without due regard to proper engine design to eliminate unnecessary hot spots, such as overheated spark plugs from which preignition may be initiated.

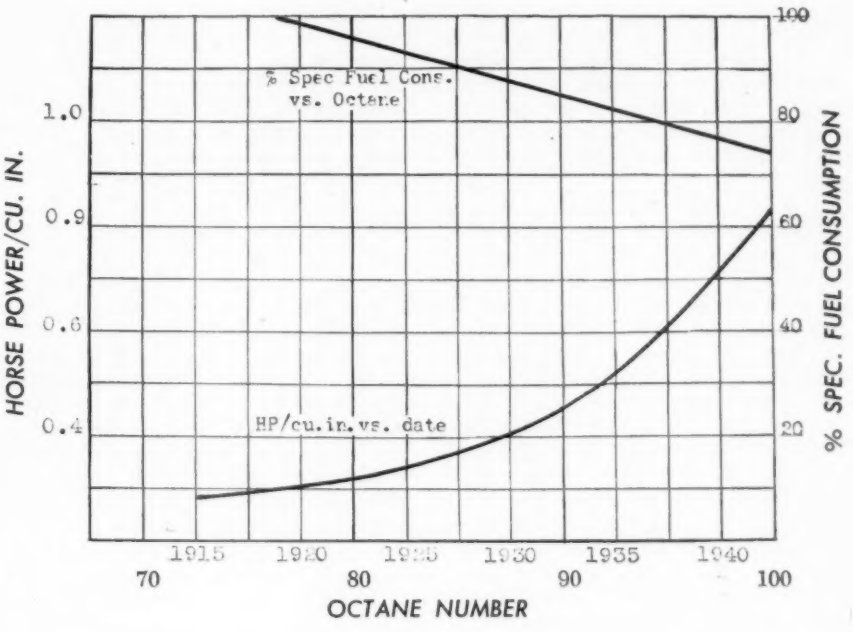


Fig. 2—Curves showing trend in improvement in performance with octane number and date. Octane number scale adjusted comparable with approximate date of introduction

In the postwar period in commercial aircraft we shall also have to consider very seriously the important question of economics, or, in other words, the minimum possible fuel consumption. On the basis of a great deal of experimental evidence, it can be shown that basically the minimum specific fuel consumption in terms of indicated thermal efficiency is related to the net heat of combustion

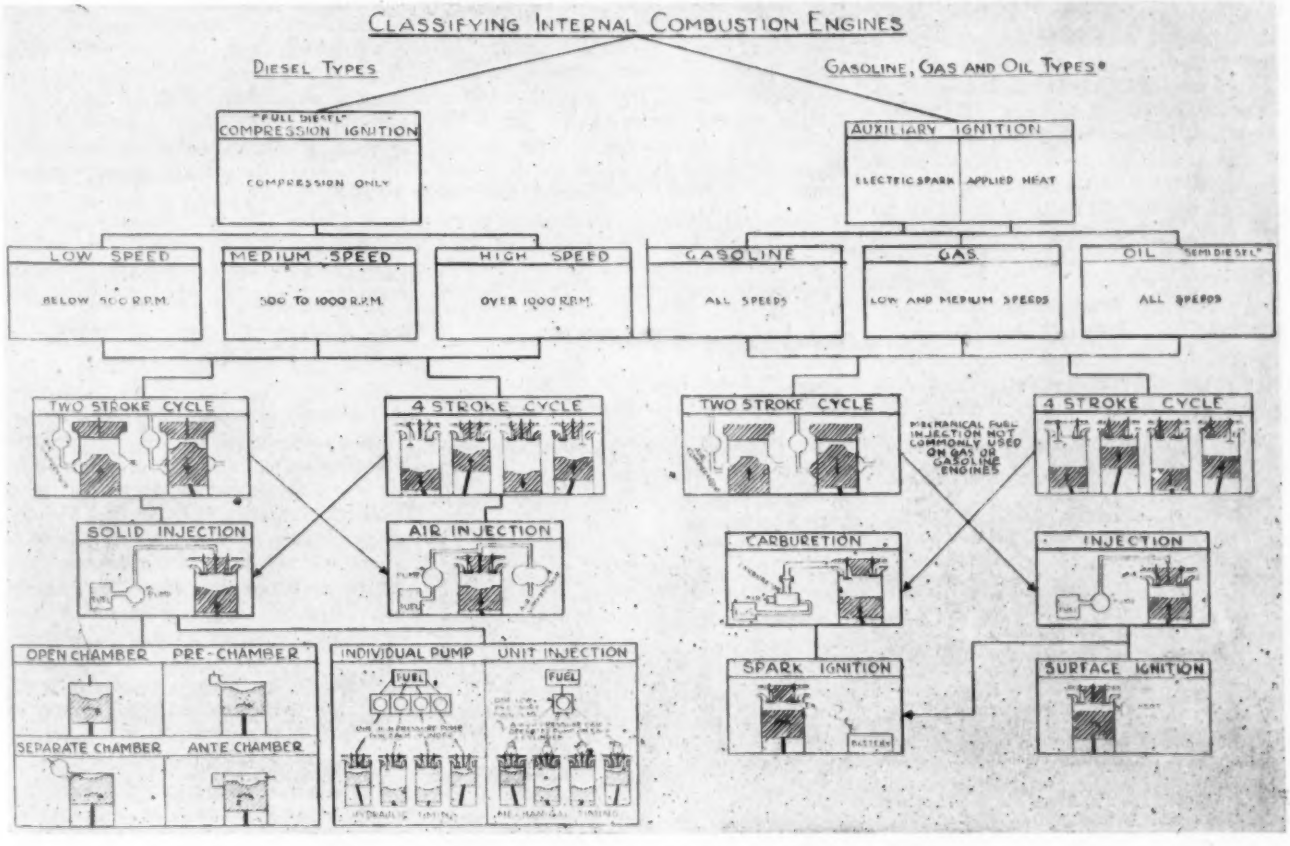


Fig. 1—Classification of types of internal combustion engines

expressed in BTU's per pound and the compression ratio at which it is burned. The highest compression ratio we can usefully employ consistent with reliable operation is limited by the maximum pressure and also by the onset of detonation or perhaps as mentioned above pre-ignition.

Fig. 3 (taken from data obtained by Ricardo) shows how rapidly the maximum pressure rises at the higher compression ratios compared with slight gains in thermal efficiency. As regards detonation, the relative effect of engine and aircraft operating conditions, for instance inlet air temperature or amount of cruising power required, on the detonation limit of the engine/aircraft combination and, thus, of the engine compression ratio which can be employed is too complex to be shown in a single figure or even discussed in any detail here. A great deal of flight detonation testing is still needed if we are to understand the problem fully. Furthermore, when we are confronted with the job of translating engine thermal efficiency into terms of pounds of fuel per aircraft flight between two given points we must consider other factors not directly related to any test bed data such as arbitrary regulations on the total fuel load required for a given trip and which may easily overshadow possible differences in thermal efficiency.

Spark Ignition Engine Fuel Requirements—Automotive Type

The subject of fuel requirements for automotive engines has been dealt with very fully indeed in past years, particularly from the postwar aspect, and a great deal of very intelligent crystal gazing has been done by numerous authors. It would, therefore, be presumptuous on my part to add anything further to these discussions. For the purpose of this general study it is sufficient to say that the problem is, in its essentials, the same as that of aircraft fuels, except that competitive marketing conditions probably play a greater part in setting the limits finally selected.

As in the aircraft engine, we still have to distribute from a common source a mixture of fuel and air to a number of

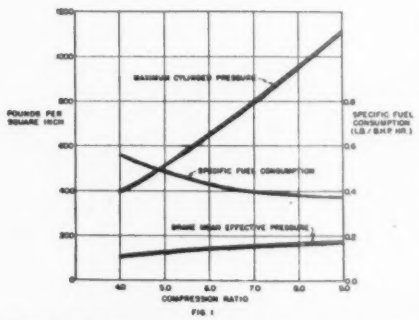


Fig. 3—Rapid rise in maximum pressure at the higher compression ratios compared with the slight gain in thermal efficiency

combustion chambers, but owing to the smaller number of cylinders and their more compact arrangement, the problem of uneven distribution is considerably simpler. Furthermore, we can take greater liberties with this point since its effect on over-all operating costs is not so important. Consequently, we can use a fuel distilling up to 380° F. for the 90% evaporated, and in a few cases perhaps even higher.

Again the problem of proper combustion is not so important, as our charge densities are considerably less, and the destructive effects of detonation are not nearly so vital. The anti-detonating characteristics of the fuel, i.e. its octane number, need not, therefore, be as high, though competition has a tendency to increase them beyond actual technical requirements and much data has been obtained to emphasize this fact.

Since cars are operated at part throttle the greater portion of their time, high compression ratios and well advanced spark timing are necessary to obtain good economy. This means that proper means must be employed for ensuring proper spark timing at all speeds and throttle openings and thus the time of igniting the charge has become a critical factor in controlling detonation rather than charge density or fuel air ratio as in the case of the aircraft engine.

Fig. 4 illustrates rather well, I think, to what extent the various compromises made to avoid detonation yet give good part load economy actually result in a loss of power at full load. This figure shows that with spark timing mechanism set to factory specifications, the average spark retard from that required for maximum torque and also the resulting loss in engine torque when using a 70-octane fuel as compared with a fuel giving no knock under maximum torque conditions. It will be noted that the average standard distributor retards the spark 7° at low speeds and at high speeds 5° for maximum torque setting. This spark retard resulted in a 3% loss in torque at low speeds and less than 2% loss at high speeds for 13 cars.

Spark Ignition Engine Fuel Requirements—Farm Tractor Type

In the engineer's constant endeavor to lower his fuel costs, a class of spark ignition engine has been developed which will operate on fuels of much higher boiling range than the two previous classes, i.e., up to 518° F. for 95% distilled. As an added incentive to achieve this object, not only have the fuels been inherently cheaper than fuels in the gasoline range, but also in many cases they are free from tax.

Basically speaking, the fuel requirement problem is exactly the same as in the other two classes of engines, though in order to achieve this even fuel distribution with the higher boiling range fuels, considerable heat has to be added to the fuel air mixture in the manifold

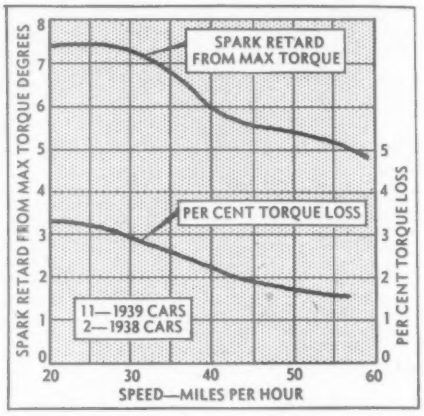


Fig. 4—Average spark retard with standard distributor and accompanying loss of torque in 13 cars

outside the cylinder in order to insure a reasonable amount of evaporation and hence even distribution between the cylinders. Also hydrocarbons of this particular boiling range are considerably more prone to detonation or uncontrolled combustion than their cousins in the lower boiling ranges. It is, therefore, necessary to keep the compression ratios much lower and hence sacrifice considerably in efficiency. Furthermore, if we are not to be plagued with the problem of excessive engine fouling by the products of half complete combustion of the heavy ends, we shall have to further sacrifice specific power output, and ability to resist detonation by heating up the air intake charge beyond the needs of distribution efficiency.

Obviously, if the tax and price situation did not enter into the picture, the engine designer would prefer to use gasoline type hydrocarbons for this class of internal combustion engine and there is no good engineering reason, excepting cost, for using this type of low grade fuel. Time does not permit us to go further into the details of the complex balance of various divergent factors here[1].

Compression Ignition Engine, High Speed Type

To burn properly heavy fuels, i.e., fuel boiling between 350° F. and 700° F. in an internal combustion engine the compression ignition type is probably far more suitable, and owing to a more thorough understanding of the process of combustion in this type of engine in recent years, developments have proceeded very rapidly. Production in the few years before the outbreak of war, was rising rapidly.

In some fields this class of engine now bids fair to be a very serious competitor to the spark ignition gasoline engine, and its fuel requirements, therefore, de-

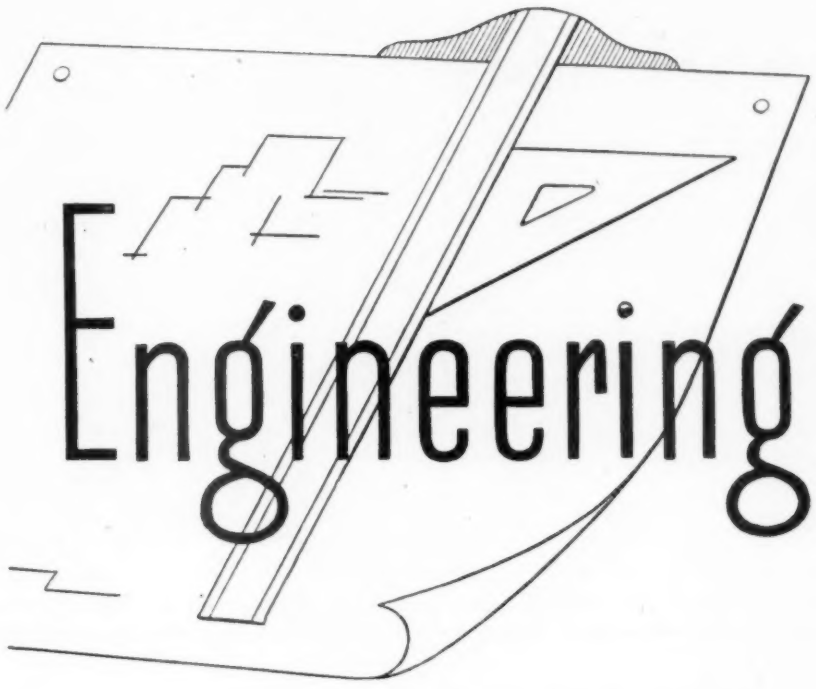
[1]For further details on this subject the author gives as a reference the paper "Fuel Requirements for Farm Tractors", by A. T. Colwell, presented at the National Tractor Meeting of the Society of Automotive Engineers, Milwaukee, Sept. 13, 1944.

serve very careful consideration, as one of its main claims to existence is its ability to use a wide variety of so-called low grade fuels. Should the compression ignition engine lose its ability to be omnivorous in its fuel and become the specialist in its fuel consumption as is its spark ignition cousin, it would lose more than half its attractiveness, particularly since the manufacture of special fuels in the higher boiling ranges is a far more expensive and complicated process than in the case of the lower boiling ranges used by the aviation type spark ignition engine.

Since we cannot hope to mix the fuel and air properly prior to their introduction into the combustion chamber with these high boiling range fuels, our chief problem becomes one of mixing the fuel and air while it is burning in the combustion chamber itself and completing the combustion in an orderly manner in the shortest possible time. Fig. 5 shows a familiar pressure time curve for a typical compression ignition engine indicating the three stages of combustion into which it is convenient to divide it. The first stage combustion is known as the delay period and should obviously be reduced to a minimum, in order that we may have as much control as possible over the other two stages. It is controlled largely by the ignition quality of the fuel and at present an ignition quality of 50-cetane number is considered adequate for most high-speed Diesel engines. Any increase above this figure does not appear to result in any appreciable gain in performance or control of the rest of the combustion process.

It is also obvious that the fuel must completely burn by the time it reaches the walls of the combustion chamber; otherwise we shall get a sudden stoppage of the combustion process and objectionable deposits of soot and lacquer and asphaltic-like compounds in vital parts of the engine, such as behind the piston rings and over the injection valve, not to mention an extremely dirty exhaust which, in certain applications, will give rise to trouble with traffic and health authorities. As far as the fuel is concerned, insuring clean combustion is very largely a function of the boiling range of the fuel, and in either separate or open type combustion chambers, a distillate fuel of not over 750° F. final boiling point seems to be the limit to which we can go in high-speed engines, i.e., mean piston speeds of 1500 ft. per min.

Furthermore, in considering the heavier type of fuels, handling difficulties such as excessive viscosity at very low temperatures must be taken into account and these points severely limit the application of this type of engine to airplanes and motor cars. As a matter of fact, I am inclined to think that the inability of even a light diesel fuel to evaporate cleanly and completely off a



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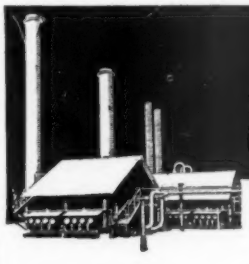

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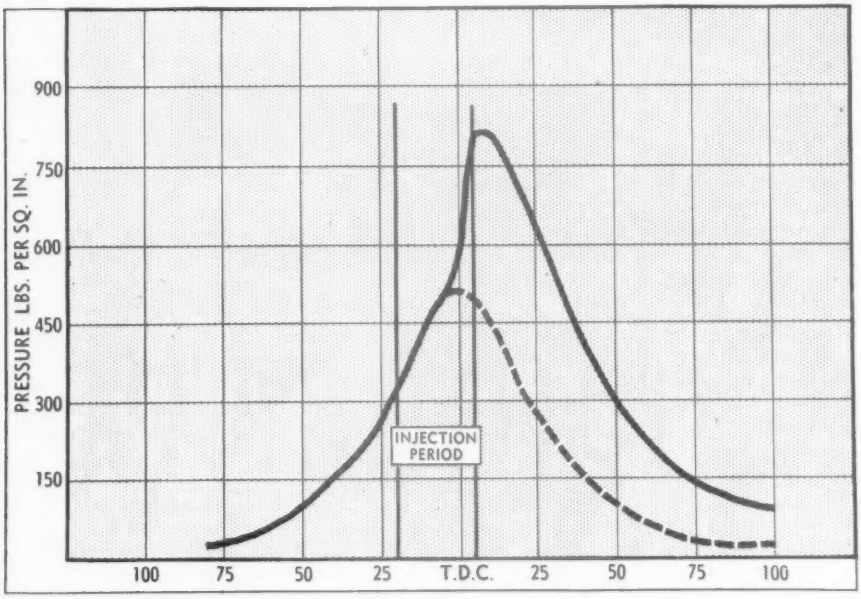


Fig. 5—Pressure time curve for typical compression ignition engine, indicating the three stages of compression. Dotted line is expansion curve for non-firing conditions

surface at normal temperatures will prevent the application of high speed diesels to passenger cars, and possibly light airplanes, since it will be impossible to keep them clean and free from an oily dust film.

As regards the future, I think we can take it almost as a law of evolution that the slow speed engine must eventually give place to its higher speed offspring. Just as we witnessed the progress of the slow speed steam engine with all its romance and unhurried dignity to the high speed steam turbine, which is no more romantic than a drain pipe, so are we now witnessing a similar development in the case of the internal combustion engine in both spark and compression ignition types. I shall deal with the internal combustion turbine in a moment, but first let me say that in my humble opinion the high speed compression ignition reciprocating engine can still be made to run a great deal faster.

Of course, before we can go far in increasing speed, without overloading our bearings we shall have to reduce our maximum pressures, and this will mean some reduction in compression pressure. Both increased speed and reduced compression pressure may mean an increased tendency to make the engine more fuel sensitive either to ignition quality, volatility, or some as yet unmeasured quality, such as rate of flame propagation.

My own guess is, however, that apart from some temporary "alarums and excursions" in the early stages of the development work, the petroleum industry will not be required to make any marked increases in cetane number or combustion quality, insofar as this depends on the chemical nature of the fuel. We may have to make slight concessions in volatility, particularly when much low load, low temperature idling is required coupled with instantaneous response to a demand for full power.

Internal Combustion Turbines

While on the subject of high speed compression ignition engines, I should like to discuss briefly the so-called internal combustion turbine. Most of the developments on this particular type of engine are on the secret list, so it is impossible here to discuss them in any detail. However, it is my opinion that combustion problems of this engine are similar to those of the separate type combustion chamber compression ignition engine, and they can well be looked at in the same light even though many turbines for one reason or another have been made to run on gasoline.

Figs. 6 and 7 show a separate combustion chamber for a four-cycle compression ignition engine and a general arrangement of an internal combustion turbine to illustrate this point. In both cases we have to circulate rapidly the minimum amount of air necessary for complete combustion to every drop of fuel entering from the fuel nozzle and to burn it in the shortest possible space of time and in the smallest possible combustion chamber.

Of necessity, some excess air will have to be used, particularly in the internal combustion turbine in order to keep the exhaust gas temperatures down to a point where they will not harm the turbine blades. But the greater the amount of excess air, the greater the amount of energy required to introduce it into the combustion chamber and to move it around the combustion chamber, and, therefore, the smaller over-all efficiency of our engine.

Turbulence must be fully controlled and arranged to hit the spray of fuel from the fuel valve so that every particle of fuel has the necessary quantity of air to insure its complete combustion before it reaches the sides of the combustion chamber or the outlet to the turbine blades.

The main difference between combustion in the internal combustion turbine and the combustion in the compression ignition reciprocating engine is the fact that in the turbine the combustion is continuous and takes place practically at constant pressure, whereas in the reciprocating compression ignition engine it is of necessity intermittent and combustion takes place more nearly at constant volume, and the flow of air and exhaust gases is reversed before and after combustion. The importance of these differences in terms of fuel requirements remains to be seen in the light of research now going on by the various interested parties.

Compression Ignition Engines, Low and Medium Speeds

The fuel requirements of low and medium speed compression ignition engines are perhaps the easiest of all internal combustion engine problems. On the other hand, of course, such engines are perhaps, in terms of space requirements, weight per horsepower, et cetera, the most unfavorable, and any developments which tend to make this type of engine a specialist in the type of fuel it consumes would, I am afraid, result in its quick demise. The better it can consume the refinery's waste paper basket, the more chance it has of successfully holding its own with its high speed offspring. It is true that its over-all thermal efficiency may be high, but its applications are limited, and at present they are used only in certain marine main engines or for some stationary power gen-

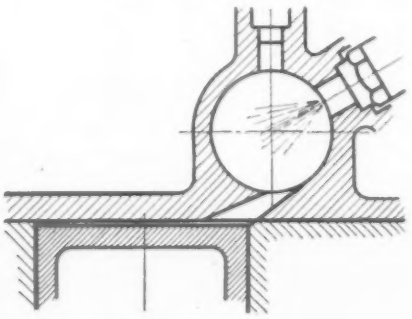


Fig. 6—Separate combustion chamber for a four-cycle compression ignition engine

eration, where special precautions can be taken to ease the fuel handling problem of heavy residual fuels. Generally speaking, its combustion problems are the same as the high speed type, except the significance of such items as cetane number are far less. There are, of course, limits to which we can go in boiling range, and this is normally determined by the Conradson Carbon content of the fuel; about 1% is, I think, a safe figure for most engines.

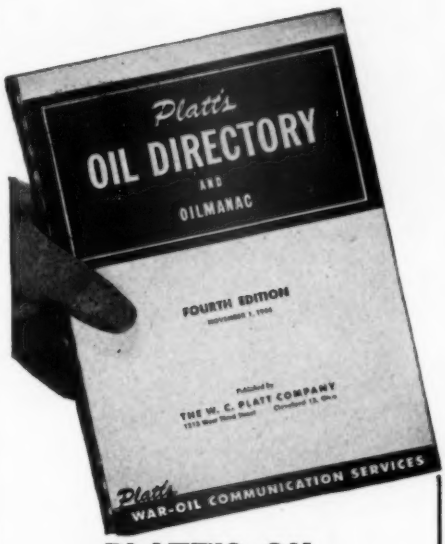
Part II—Fuel Availability

Practically all the three to four billion horsepower of internal combustion engines in use in the U. S., as well as several million horsepower developed outside the U. S., has, and will continue, to rely on liquid fuels of petroleum origin for the main source of energy. Present crude production amounts to 4.7 million barrels a day, and though, of course, there is a limit, there appears to be ample crude for many years to come.

A small number of engines will undoubtedly use natural or artificial gas in suitable locations, but so far as I can see, there is little likelihood in the immediate future of internal combustion engines being able to consume solid fuels in powdered form, and the manufacture of liquid fuels from coal is for the present out of court on the charge of expense. No doubt those more familiar with the recovery of oil from shale or the conversion of coal to oil will be prepared to challenge me on this point, but I think my stand is substantially correct for a good many years to come as far as this country is concerned.

The use of alcohol from farm products, from a philosophical point of view, might appear to be an attractive proposition since we would be using income energy; i.e., energy as it is stored up by the sun, instead of capital energy; i.e., energy which has been derived from the sun and stored underground many millions of years ago. However, such fuel is not attractive at the present moment since it cannot be produced at anything like the cost of fuels produced from crude petroleum. Furthermore, the calorific value is only about two-thirds that of the normal petroleum hydrocarbons of corresponding boiling range, and, consequently, in terms of BTU's per gallon or per pound of fuel, we would take a double licking.

Now apart from a few compression ignition low speed type engines which are handy to crude petroleum sources such as pipeline pumping engines and some Diesel-engined ships, crude petroleum as such is seldom used as an internal combustion engine fuel and is far more efficiently used if it is subjected to some refining process. The modern refinery is a very complex organization, and changes made in one phase of its operations to produce a different quality or quantity



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of some particular type of fuel frequently affect the quality or quantity of other types of fuel produced. Great care, therefore, has to be used in planning fuel specifications that proper refinery balance is maintained. For the purposes of the following discussion, however, we need only confine ourselves to crude distilling or topping plants and the thermal and catalytic cracking plants, and in the case of aviation gasoline, the volatile recovery and process plants for the manufacture of hydrocarbons of specially high antiknock characteristics. However, it should not be forgotten that the necessity

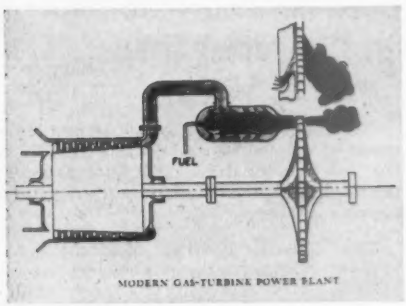

Fig. 7—General arrangement of an internal combustion turbine

for producing other products often affects the fuel picture since it frequently governs the type of crude which has to be processed, and hence the type of operation of the fuel producing plants.

Topping

The first operation to which crude oil is subjected in the refinery is a distillation which separates the crude into fractions of various boiling ranges. The primary products from this operation as far as fuels are concerned are wet gas, gasoline, naphtha, kerosine, light fuel oil, gas oil, and topped crude or residuum. Generally speaking, crudes which yield gasolines of high antiknock value yield kerosine and Diesel fuels of poor ignition value and vice versa. Furthermore, there are few crudes which yield straight-run gasoline in any quantity of sufficiently high antiknock value to be of real use for present day requirements for spark ignition engines and resort has to be made to the cracked gasoline to augment this demand.

Nevertheless, straight-run gasoline of 70/73 octane number is produced in sufficient quantities to make it a valuable component of high quality aviation gasoline and the topping process produces large quantities of very volatile hydrocarbons such as butane which are no use per se owing to their vapor locking tendencies, but which when married to the light hydrocarbons evolved by the cracking process in the alkylation plants produce very high octane number fuels for aviation engines.

Cracking

Thermal cracking was the first cracking process developed and consists fundamentally in breaking down hydrocarbons of high molecular weight by subjecting them to a temperature of 900-1100° F. at pressures ranging from 100 to 1000 psi. Gas, a distillate which can be treated and distilled to make gasoline, a fuel oil cut, and a heavy residuum, is produced thereby. The charge to the process is not completely cracked in a single pass through the cracking furnace, and, therefore, some of the fuel oil cuts are repassed through the furnace and further cracked. The type of fuel produced depends largely on the cracking conditions used and on the nature of the charging stock. Broadly speaking, however, cracked gasoline has a higher anti-detonating value or octane number than the straight-run gasoline from the same crude, but its anti-detonating value is somewhat more sensitive to changes in engine conditions, particularly temperature.

The charging stock frequently employed in thermal cracking plants is the topped crude or residuum, a fuel which is not satisfactory as a general rule for internal combustion engines due to its high boiling range, and consequent difficulty of handling at normal temperatures. Low octane number straight-run naphthas or high boiling gasolines can also be used in a modified thermal cracking process known as reforming to produce motor gasolines of high quality and good resistance to detonation.

Catalytic cracking as its name implies, cracks distillate fuels into gasoline at relatively moderate temperatures and pressures in the presence of catalysts which assist the cracking reaction. It was first commercially used in 1936 and its growth since that time has been extremely rapid. In 1940 thermal cracking capacity in the U. S. was about two million barrels per day and catalytic capacity only in the order of 125,000 barrels per day. At the war's end, thermal cracking will not be greatly changed; it may even decline somewhat due to the obsolescence of some of the equipment but the catalytic capacity will have reached a figure of over 900,000 barrels per day.

Gasoline produced by catalytic cracking is of somewhat higher quality than thermally cracked gasoline in respect to octane number and stability of octane number to engine conditions and at present the majority of it is being used to produce aviation gasoline base stock and all of the increased catalytic capacity of recent years has been built with this in mind.

Refinery Balance

Now, the installation of catalytic cracking units during the war constitutes a major change in refinery operations, and the exact manner in which these catalytic units will be used after the war cannot now be exactly predicted. Both thermal and catalytic cracking permit considerable flexibility in operations, but any readjustment of cracking conditions to improve gasolines for the spark ignition engines usually results in degrading the fuels remaining for the compression ignition engines. Cracking can also be used either to produce increased volumes of gasoline from the same amount of crude previously charged with a decrease in production of both light and heavy residual fuels, or, if the same gasoline production is assumed, to add additional light fuel at the expense of heavy.

Some refineries which have not installed catalytic units will continue to operate much as they did before the war. On the other hand, if it be shown essential that more straight-run fuel be made available for the compression ignition engine in preference to the catalytically or thermally cracked fuel, the picture could be changed provided the available balance was maintained or the demand for high octane gasoline was such that it would be more profitable to use it as charging stock for catalytic cracking units. It is not my intention here to predict quantities of each type of fuel likely to be available or changes in refinery operation, but merely to show that within reason changes can be made in fuel quality should it be

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8-12, Society of Automotive Engineers, annual meeting and engineering display, Book-Cadillac Hotel, Detroit.

17, American Society for Testing Materials, New York District—"Petroleum and Some of Its Modern Derivatives", Engineering Societies Bldg., New York City.

FEBRUARY

28, American Society for Testing Materials—Spring Meeting, Hotel William Penn, Pittsburgh.

MARCH

12-14, National Association of Corrosion Engineers, President Hotel, Kansas City, Mo.

MAY

16-17, Society of Automotive Engineers, Diesel Fuel and Lubricants Meeting, Hotel Carter, Cleveland.

JUNE

18-22, American Society for Testing Materials, 48th Annual Meeting, Hotel Statler, Buffalo, N. Y.

SEPTEMBER

10-14, American Chemical Society, Chicago (ACS will not hold its customary Spring meeting this year).

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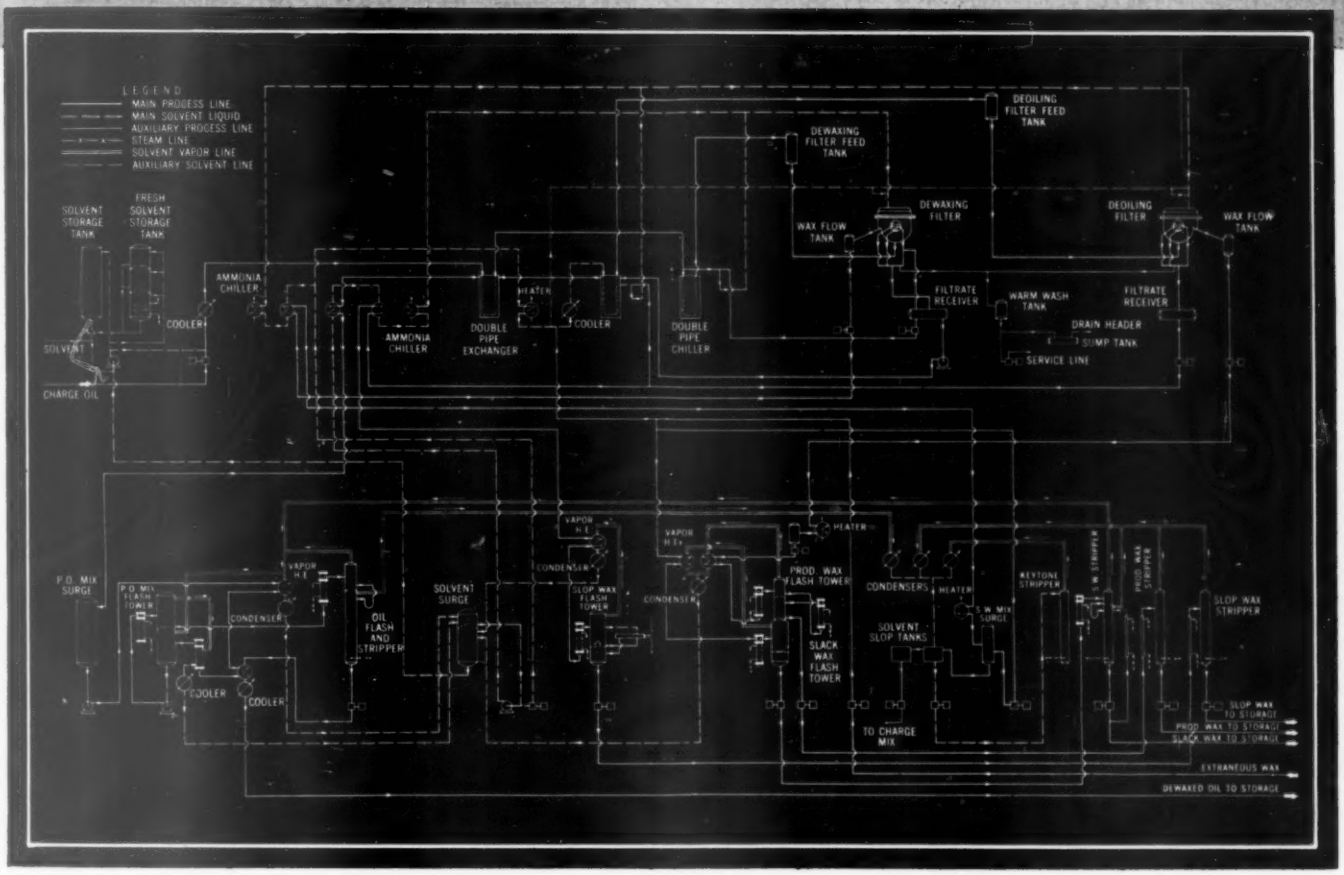

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shown necessary and economical to do so.

Part III—Cooperative Research Problems

In many cases competition has far more effect on the quality of the fuel marketed, particularly in properties like octane number, than any technical requirement of the engine itself. However, any increase or decrease in quality of an internal combustion engine fuel must have some technical justification regardless of competition, and it is, therefore, appropriate to look at the two halves of this picture for a moment and see if we can line up some problems which must be solved in order to marry the availability picture as given above with the fuel requirement picture as outlined broadly in the first part of this paper on a sound technological basis.

Cooperative research with a view to making the most happy and durable marriage between internal combustion engines and their fuels has had in this country a long and enviable record of success under the auspices of the Society of Automotive Engineers and the American Petroleum Institute, working through the Coordinating Fuels Research Committee, better known perhaps as the C.F.R. Committee. It might, therefore, not be out of place to wind up this rather broad discussion of engines and fuels by outlining some of the more obvious problems which appear to warrant the C.F.R. Committee's serious consideration in order that the happy marriage may continue, and, I hope, produce healthy children.

In the spark ignition engine field, both in aircraft applications and in automotive applications, the problem of detonation in its many forms is still with us. For aircraft engines, the principal problems with which we are now faced and with which I think we will continue to be faced for some years to come are (a) the improvement in our methods of measuring detonation so that they are more exact or reproducible, and (b) how to interpret our laboratory ratings of anti-detonation value in terms of actual flight performance and the development of methods of analyzing the many interlocking factors which determine the detonation limit of a particular aircraft engine combination.

(a) is vital at the moment and could well absorb the whole of the engines of the aviation fuels division. Even slight increases in reproducibility between engines and laboratories can increase the amount of high octane gasoline available to the military services by substantial amounts, perhaps as much as 5 to 10%. The reason for this is that high octane blending agents, as they are called, are exceedingly precious these days, and by being able to measure octane number more exactly we can work more closely to our specification limits without the refiner having to leave such a large safety margin to insure satisfactory gasoline in the aircraft tank. For the future civil aircraft picture, this is equally important since these high octane blending agents are very expensive so that when the stress is taken off availability and maximum production, it will still be important in order to save dollars and cents.

(b) is also of considerable importance, particularly for postwar consideration so that we may have an accurate gauge of the value of increasing octane numbers in terms of increased flight horsepower or flight fuel consumption. This will enable us to balance the cost of increasing octane numbers with the benefits obtained from them in terms of decreased operating costs.

The phenomenon of preignition also deserves serious attention by a cooperative group if we are to continue our engine development program towards higher compression ratios and hence higher efficiencies. Programs have already been initiated in some laboratories, and it is to be hoped when the preliminary work has established the proper field of endeavor a well conceived cooperative test program will be undertaken.

In the field of automotive application, the problem of how to interpret laboratory ratings of octane numbers in terms of actual road performance is also an important problem as it is in aircraft, though with perhaps a somewhat different objective. In this case a great deal of information is already available on the basis of thermally cracked and straight-run gasolines but little in terms of catalytically cracked gasoline. Furthermore, the octane number level at which this information is available is lower than the level which the best experts anticipate will hold after the war. Consequently, our first effort will largely be a sort of check test.

After that it is possible that more radical engine designs will begin to take shape, and it will be necessary to determine, as in the case of aircraft engines, the "profitability" of increased anti-knock characteristics, and under what conditions these anti-knock characteristics should be most in evidence. It may well be that the result of these researches will bring forth a new method of rating fuels in the laboratory which is more directly indicative of their road performance.

However, from what we know now, no one method will be sufficient for all new types of fuels under all possible operating conditions, and no one yardstick will ever be sufficient for the research engineers in both the petroleum and automotive industries.

The problem of even fuel distribution will, of course, still be with us, but I am inclined to think that from a research standpoint little can be gained from cooperative research. It is true that the petroleum industry will wish to make use of somewhat higher boiling hydrocarbons for the spark ignition engine, particularly in the aircraft field, than it is now doing. But before any useful accomplishments can be made in this direction I think we shall have to wait on further mechanical developments by the engine industry in the field of fuel injection and possibly stratification in the combustion chamber. The industry is familiar with the necessity for doing so and has, I imagine, several ideas as to how this could be carried out. The matter, therefore, seems to be one of education of the engine industry to carry forward their program rather than the initiation of a cooperative program.

Similarly, in my opinion, the work on tractor fuels is largely one of educating the tax authorities for the need for uniform tax laws and for the engine industry to standardize its designs somewhat on the basis of the newly proposed classifications.

In the field of compression ignition engines there is a fruitful field in the investigation of the importance of ignition quality, or shall I say combustion quality. In the early days when the importance of ignition quality was first brought out, considerable stress was laid upon the importance of investigating ignition quality with a view to rendering it an unimportant factor in fuel specifications. To a large extent this objective has been achieved, and many of the more successful high speed compression ignition engines are not sensitive to ignition quality.

Now, however, the time would appear to be ripe for increases in speed and decreases in compression ratio, two features which must be improved if the progress of the high speed diesel is to be maintained and it may well be that ignition quality or combustion quality is of greater importance as speed is increased or compression ratio decreased. I feel, therefore, it would be well worth the time of both industries to study this field cooperatively in the near future, and to see if, with higher speeds and lower compression ratios, the newer type fuels such as catalytically cracked gas oils do show combustion characteristics markedly different from their prewar cousins.

Furthermore, as I explained at the beginning of this paper, the combustion phenomena in the so-called internal combustion turbine and high speed diesel are substantially the same, and the problems I propose can be readily expanded into an investigation of the importance of ignition quality and perhaps boiling range into the combustion of hydrocarbons under very high air velocities in very small space at moderate pressures.

I do not mean to infer that the above suggestions are the only ones which will require investigation by the C.F.R. They are not, but they are perhaps the most important ones which will require an extended program of carefully laid out experimental work. It may also appear

to some of you that the number of projects I have suggested is small in comparison with the large organization of some 150 working groups now performing under the C.F.R. However, in my humble opinion we should do well to consider a deflation program in the number of our cooperative projects as soon as military requests permit, and concentrate on those with the most promise of practical success in the true field of C.F.R., the cooperative development of methods of evaluating in significant terms the performance of our postwar fuels in our postwar internal combustion engines.

In conclusion, I should like to acknowledge my grateful thanks to all my colleagues in Shell Oil for the help they have given me in generous measure in getting together the material and to the management of the company for permission to publish this paper.

GR-S Processing

(*Continued from p. R-6*)

natural product. Both properties together create the difficult problem of making the nylon cords and rubber adhere together during the process of building the tire.

The "problem child" is that heavy-duty truck tires which had previously been made of 100% natural rubber and rayon fiber cords—and was the ultimate in tire construction. The use of synthetic in these tires will have to await further advances in the technology of making and handling synthetic rubber.

Harvey S. Firestone, Jr., recently stated that "we have every confidence that one of these days we will be able to produce an all-synthetic rubber truck tire which will approximate the performance of one made with natural rubber."

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The Use of CHEMICALS by the Petroleum Industry*

*By Raymond Reuter***

The volume and diversity of chemicals used in refining and other branches of the petroleum industry has expanded greatly in the wartime emergency. The new processes, being mainly catalytic in character, have created large demands for new chemicals. Shortages of critical materials have also brought into use substitutes for the more common chemicals formerly used.

Research and development work has introduced new types of additives for lubricating oils. While these at present are restricted to oils for direct or indirect military use, it is expected there will be a large increase in the use of additives in oils for passenger car, truck, bus and aircraft service after the war.

THE variety of chemicals the petroleum industry employs in its own operations has been increasing each year. According to a survey that was made early in the year 1942, petroleum refiners used about 550 different chemicals, including about 100 compounds that were sold only under trade names. These 550 items were totaled from chemicals that were purchased in quantities of 50 pounds or more during the year by an individual refiner. It is interesting to note that today we are shipping hydrofluoric acid to refiners in tank cars and this item did not even appear on the earlier list.

This discussion will touch only on some of the highlights. There is no attempt to be all inclusive. We will divide the discussion up into three groups. The first contains chemicals used as catalysts; the second contains those used as inhibitors; the third we will, for lack of a better term, simply call other processing chemicals.

I. Catalysts

All but a very small portion of the components that are blended to make 100-octane aviation gasoline at one time or another in their production cycle come in contact with a group of chemical agents commonly called catalysts. These catalysts cover a wide field of chemical compounds. All of them have definite life spans and must be replaced at varying rates.

Synthetic Cracking Catalysts

Sodium silicate, ammonia, alumina and sulfuric acid are the principal raw materials from which synthetic cracking catalysts are made. Much publicity has been given to the 20-story high catalytic crackers that have appeared in our oil refineries since the start of the war. Fluid Cat Crackers, Thermofor Cat Crackers, Houdry Cat Crackers and Bead Cracking Catalyst are names that are commonplace in the industry today. The Fluid, Houdry and Bead synthetic catalysts are each made in plants that were built specifically for the purpose. The Fluid is a fine powder, the Houdry is in the form of pellets and the Bead is in the form of spheres. Although the physical form of each is different they are not greatly different chemically. Chemically they may be classed as silica gels. The total combined capacity for the production of synthetic cracking catalysts in the country at present amounts to over 200 tons per day and the amount of money invested is in the order of $15,000,000.

Natural Clay

Naturally mined clays that have been specially treated are much less expensive and have been used to start up many of the Fluid cat crackers. Pelleted natural clay is used in most of the Thermofor crackers although synthetic Beads are used in some of them. The natural clays may compete with the synthetic after the war in cracking for civilian motor fuel where the octane requirements are not so high.

Aluminum Chloride

Aluminum chloride, sometimes with the addition of antimony chloride to keep a liquid phase, is used as a catalyst in the isomerization process that converts normal butane to isobutane. This catalyst must be quite pure and free from iron. It is commonly produced by treating molten aluminum metal with chlorine gas. The isobutane is used as feed stock for the alkylation process which we will discuss a bit later.

Hydrogen Chloride

About 100,000 pounds a month of anhydrous hydrogen chloride are used along with aluminum chloride in the isomerization process. Most of this is by-product gas from a large Mannheim furnace. It is compressed and sold in 55-pound cylinders. The remainder of the HCl is produced at the point of use by any one of several established methods.

Sulfuric Acid

The alkylation process, which makes one of the highest quality components of 100-octane aviation gasoline, uses either sulfuric acid or hydrofluoric acid as catalyst. Refineries that already had sulfuric acid plants or that used considerable amounts of sulfuric acid for treating gasoline, kerosines and lube oils, chose to use sulfuric acid for alkylation. The small amount of excess spent acid that was left over from the cycle after refortification for re-use in the process, was absorbed in oil treating operations.

However, in most plants this cycle soon got out of balance because the war demand for alkylate became so great. Spent sulfuric acid began to pile up in storage and disposal became a real problem. This spent alkylate sulfuric acid is about 88% H_2SO_4 and contains a relatively small amount of sludge. Refiners for years had been familiar with the heavy acid sludges that were formed when naphthas and oils had been treated with sulfuric acid. Because of their high carbon content these could be burned on a dump, or with careful control, could be burned under boilers. But this new alkylate spent acid with very little sludge content was different and could not be so burned without a great deal of fuss and without fumigating the entire landscape with SO_2.

The spent alkylate acid disposal problem has been solved in two different ways. Some plants are hydrolyzing the spent acid under conditions that remove most of the carbon and end up with a 58% strength acid. This hydrolyzed acid has acquired inhibition properties that it has apparently picked up in the alkylation cycle and it is being shipped successfully in ordinary steel tank cars, usually to phosphate plants where it is fortified up to 68% strength for use on phosphate rock to make fertilizer.

The second disposal method is also a recent development. The invention of a new type recuperator has made possible the direct burning of spent alkylate acid for new acid production. The realization of a proper heat balance in this operation has been attained by burning a small portion of fresh sulfur along with the spent acid. The SO_2 formed is then passed in the conventional manner over a contact catalyst to make SO_3 which is then absorbed in dilute acid to make strong, water white H_2SO_4. Sulfuric acid produced in this manner is more expensive than acid made directly from sulfur or pyrites, but the process affords an economical solution of the spent alkylate acid disposal problem.

The estimated 1945 requirements for the entire country are 10,556,200 tons of sulfuric acid of which the petroleum industry will demand about 2,000,000 tons. This requirement figure is exclusive of that supplied by the wholly owned Ordnance acid plants but does include requirements that can be satisfied by both new and spent acid. Strict conservation methods are being practiced within the petroleum industry. Wherever it is possible to substitute

*Presented before the Chemical Market Research Group, New York, Dec. 8, 1944.

**Petroleum Administration for War, Refining Division, Washington.

spent alkylate acid for fresh acid, this is being done.

Hydrofluoric Acid

In general, refineries which did not already use much sulfuric acid chose hydrofluoric acid as a catalyst for the alkylation process because this acid may be recovered by simple distillation. Although anhydrous hydrofluoric acid had been used commercially before the war this petroleum usage was the first of any great magnitude. The requirements of hydrofluoric acid for Freon manufacture now run it a close second. The acid will attack glass and cause painful burns on the skin. It can be handled in steel that is free of slag inclusions. A very thorough educational program on methods of handling this chemical was carried out to insure the safety of the refinery workers.

The consumption of acid in actual experience has been more than was anticipated by the designers of the process. A good part of this is due to failure of materials resulting in actual mechanical leakage. These difficulties are being slowly overcome. The merits of the use of hydrofluoric acid compared with sulfuric acid can be debated at some length and if the choice of process had to be made over again, it would probably depend upon the idiosyncrasies of the individual refiner.

Phosphoric Acid

Phosphoric acid and some phosphate salts are used as the catalyst for manufacturing cumene. To make this aviation gasoline component, benzene and propylene are united by passing them over the catalyst at elevated temperatures. The same catalyst is being used to polymerize light olefin gases to unsaturated liquids that are usually spoken of as copolymers. This copolymer which consists mainly of octenes is hydrogenated in separate equipment to form octanes that are blended into aviation fuel.

Hydrogenation and Dehydrogenation Catalysts

Salts of nickel and tungsten form the base of the catalyst that cause hydrogen to add to hydrocarbons. In addition to copolymer, certain other unsaturated hydrocarbons of proper boiling range are hydrogenated to make components of 100-octane gasoline. Oxides of chromium and molybdenum along with some iron are the principal ingredients of catalysts that cause the removal of hydrogen from hydrocarbons. Examples of these dehydrogenation catalysts are the ones to make butylene from butane, to make butadiene from butylene and to make toluene from naphthene hydrocarbons. The catalyst used to make toluene and related aromatic hydrocarbons from naphthenes is also called a hydroformer catalyst and the process is called hydroforming. Several times as much toluene for T.N.T. is now made from petroleum as was ever made from coal tar and this requires a few million pounds of hydroformer catalyst a year.

II. Inhibitors

Inhibitors, as we all know, behave in a fashion which is the opposite to the way that catalysts behave. They slow down or prevent reactions, while catalysts speed up or promote reactions.

Tetraethyl Lead

Probably the first inhibitor that comes to mind in connection with petroleum will be tetraethyl lead which suppresses knock. There has been a large expansion in tetraethyl lead producing facilities since the start of the war. This has required expansion in the production of related chemicals, specifically, sodium metal, ethyl chloride and ethylene dibromide. In order to increase ethylene dibromide production, expansion was necessary in the manufacture of chlorine that is required to make bromine from sea water.

Tetraethyl lead may be considered the most important component of 100-octane gasoline because, although other components can be juggled about, nothing takes the place of lead. Currently, at least, tetraethyl lead is always added in the amount of 4.6cc per gallon. Its production now is measured in hundreds of millions of pounds per year and is three times what the production was in 1939. At present nearly 80% of the total tetraethyl lead consumption is in direct military use. This explains why your car is so prone to knock today.

Gasoline Gum Inhibitors

Gasoline gum inhibitors are necessary additions to most all grades of motor fuel and are very important to the 100-octane gasoline that is being shipped overseas, some to be stored several months in tropical climates. These inhibitors retard the absorption of oxygen by unsaturated components in the gasoline and thereby prevent the formation of gum-like materials that cause sticking of carburetor floats and plugging of jets and fuel feed lines on automobiles.

Most gasoline gum inhibitors belong to the class of complex phenols. Alpha naphthol, one of the simple phenols, was used to the extent of 2,500,000 pounds per year for this purpose back in 1941. The exacting requirements of 100-octane and other military fuels have displaced this simple phenol with the much more complex benzyl and butyl amino phenols and phenylene diamines. Although their increased production has been assisted by high priorities the supply is still short enough so that they are under full allocation by the War Production Board.

Lubricating Oil Additives

In recent years the lubricating oil departments of the petroleum refiners have come to talk about what they call "additives." Additives are chemical compounds that are blended into oils to impart desirable qualities that are lacking in the oils themselves. Among these qualities are detergency, oiliness, ability to disperse sludge particles and ability to maintain continuous films under conditions of extreme pressure. None of the compounds that furnish these qualities are inhibitors so we will pass them by for the moment.

One of the newest additions to the group of lube oil additives, however, is an inhibitor that has conquered foaming. It is a chemical that belongs to the class of organic silicon compounds that only recently have come into commercial production. The fact that an engine oil will foam may not be very impressive on first thought, and it is true that it is not too common an occurrence. In certain instances of routine heavy duty operation, however, forced engine shutdowns have occurred due to continued loss of oil from foaming. Obviously it could be fatal to have such a condition in a PT boat engine during a naval operation or in a tank engine during a tank battle.

Lubricating oils have been inhibited against *oxidation* for a number of years and a variety of chemicals have been employed for that purpose. Organic phosphites were among the earliest, and phosphorus still plays a major role in the more complex molecules being used for this purpose. The manufacturers of phosphorus pentasulphide first found themselves pressed for production a few years back and this compound remains today as one of the building blocks of the more complex molecules.

A great deal of research has been expended in the last half dozen years on lubricating oil additives and at the beginning of the war several chemical companies already had invested the considerable sum of money that is required to operate an automotive testing laboratory. Most of these were modeled after existing laboratories of the oil refiners or motor car manufacturers. With the entrance of the U. S. into the war the supply of a number of the chemicals used to synthesize the lube oil additives was restricted. This was particularly true of the higher molecular weight alcohols whose raw material sources lay outside of continental U. S. During the period of the war the controls have been such that only those additives most economical of critical chemicals could be used and those only in oils for direct or indirect military purposes.

As soon as these restrictions are removed it is quite certain that there will be an immediate increase in the variety of lube oil additives appearing on the market for special uses in passenger, bus, truck, and aircraft service. To give you another picture of what these chemical additives mean in terms of performance, it was only some few years back that our submarines had to completely change their engine oil after a one-way trip from San Francisco to Hawaii. At present with the aid of these new type lubricat-

ing oils submarines can make a round trip and more over this same route without changing oil. Turbine oils which are a special class of lubricating oils likewise have been greatly improved during the last few years by additions of chemicals similar to those discussed above.

Water Corrosion Inhibitors

An entirely different class of chemicals used as inhibitors are the water soluble chemicals used to prevent water corrosion. In building the 100-octane gasoline plants many heat exchangers were designed to run at much higher capacities than had been the normal custom. In addition, the War Production Board ruled that ordinary steel tubes would have to be employed for heat exchangers because the water corrosion resistant alloys were needed for condenser tubes for the large ship building program.

Refineries which in pre-war days got along very well on a routine repair and replacement schedule found that these new heat exchangers were requiring a great deal of attention. Some refiners who had previously used no chemical except a small amount of chlorine to keep down the growth of algae in their systems found that they needed something more to protect against corrosion and scale. Water treating has become more and more a complex science. Chemicals now used for this purpose include silicates, phosphates and chromates. Complex organic compounds of chromium with certain of the sugars have been found to be effective in very low concentration. In some cases after a large initial dose, a concentration as low as 5 to 10 parts per million has been sufficient to maintain the protection.

Such compounds are very useful where heat exchanger water after absorbing heat is recooled by being sent to an open tower cooling system where considerable evaporation occurs. Under conditions where there is a large loss of cooling water by evaporation, there would also be precipitation and loss of any compound which had to be employed in a concentration of hundreds of parts per million in order to be effective.

The use of some of the chromium compounds has been severely limited during war time by the critical nature of the raw material supplies that have been in demand by higher priority war uses. Oil pipe lines have to be protected against internal corrosion from the slugs of water that accumulate. Sodium nitrite, which is patented when used for this purpose, has been very effective in keeping pipeline capacities up to their rated figures.

III. Process Chemicals

A number of other common chemicals which are classed neither as catalysts nor inhibitors are used in large quantities by the petroleum industry.

Alkali

Among the alkalis we can name first sodium hydroxide. There are over 220,000,000 pounds of sodium hydroxide consumed yearly in the industry. The hydrofluoric acid alkylation process has called for increasing amounts of potassium hydroxide solution. This alkali is employed because potassium fluoride is a much more soluble salt. Potassium hydroxide is therefore much more prompt in effecting complete neutralization of acid spills.

The requirement for potassium hydroxide is rather difficult to estimate because if a hydrofluoric acid alkylation plant always functioned perfectly and there were no acid spills, the requirement would be almost nil. However, as stated earlier in this paper, the startup of some 27 hydrofluoric alkylation plants since the beginning of the war has recorded many more leaks, shutdowns and repairs than was ever anticipated. This has directly affected the consumption of potassium hydroxide.

Clays

The naturally occurring ore, bauxite, is used in the hydrofluoric acid alkylation process both for drying the charge gases and for absorbing from the products the last traces of acid and organic fluorides. The demand has been particularly heavy during the break-in trials of these plants. Some operators have contended that silica picked up from the impurities in the bauxite gets back into the process in the form of fluosilicic acid. This acid in time forms sludge-like deposits at critical points in the equipment.

Alumina is the term employed in contrast to the term "bauxite" when one refers to a material that is free from iron and silica. Alumina is being employed by some of the alkylation operators at present in an effort to eliminate the sludge deposits in the equipment.

Solvents

A group of well known chemicals are employed in the solvent extraction processes for lubricating oils. The lubricating oil fraction of a crude may be separated from the rest of the crude by distillation and it may be either an overhead distillate or a residue.

This lube oil fraction will contain different percentages of paraffinic type hydrocarbons and naphthenic type hydrocarbons and, depending upon the purpose for which the finished oil is to be used, it is desirable to retain or eliminate one or the other of these types of hydrocarbons from the mixture. This is where the chemical solvents come into play and the particular solvent to be chosen in any particular case will depend to a large extent upon the degree of selectivity that that solvent has for the naphthenes or for the paraffins.

More than 7,000,000 pounds of phenol and orthocresol combined are now consumed yearly in lube oil solvent extraction processes. Furfural, chlorex (which is the trade name for dichloroethyl ether) nitrobenzene and sulfur dioxide are also used commercially. The DuoSol process, which uses a mixture of phenol, orthocresol and propane, is representative of a process that can handle crudes containing asphaltic and other heavy material in a plant which takes a relatively large investment to build.

As an example of the other extreme, the chlorex process can operate in very simple equipment and effect a relatively smaller quality improvement. In fact one operator boasts that he built his plant entirely from second hand equipment and baling wire. If proper charging stock is available the product from the latter process may be just as serviceable as that from the former process.

The solvent dewaxing process which is often employed in series with other lubricating oil refining operations has successfully employed mixtures of methyl ethyl ketone and benzene and toluene. The proportions of these chemicals and the temperatures employed in the process are usually adjusted so as to give the desired crystalline structure to the waxes being isolated. This process has enabled refiners to separate new types of waxes. Some of the so-called "mal-crystalline" waxes have special desirable properties such as tackiness. These waxes were unknown in the days when all wax was separated by simple chilling and pressing.

Benzene has been used intermittently for years by the petroleum industry. It has been blended into gasoline or not blended as the price went up or down. During war-time a small proportion of benzene has been allocated to very essential chemical manufacture. All the rest of the benzene available in this country plus importations from other countries has been used by the petroleum industry to make cumene which is the other name for isopropyl benzene. This material is one of the high-quality blending components of 100-octane gasoline. Its cost is high, however, and it is doubtful that this material will be used as a peace-time component of gasoline except in isolated instances.

Fire Fighters

The last group of compounds that I am going to name in this list of chemicals used by the petroleum industry includes two materials that are very commonplace, plebeian sort of chemicals. However, when a fire has been raging all afternoon and you want to put it out, a cloud of carbon dioxide or a blanket of foam made from alum salts will usually do the trick.

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Inquiries for reprints in quantities of articles appearing in NPN's Technical Section should be forwarded promptly after receipt of the issue, by telegram if possible. Present conditions make it impossible to hold the type in the forms after the issue has been published and reprints ordered after the type has been broken down have to carry the additional cost of resetting the article.

(*Continued from p. R-14*)

war effort, portable laboratory units, equipped with the most modern scientific equipment, have been designed, built and are now in operation. The results of these precise investigations have been invaluable in the development of a program to supply the light hydrocarbon requirements of the war. However, due to the confidential nature of the information secured from the companies operating in the areas studied, these reports cannot be published in their entirety, but it is hoped that a general technical study will be available after the war.

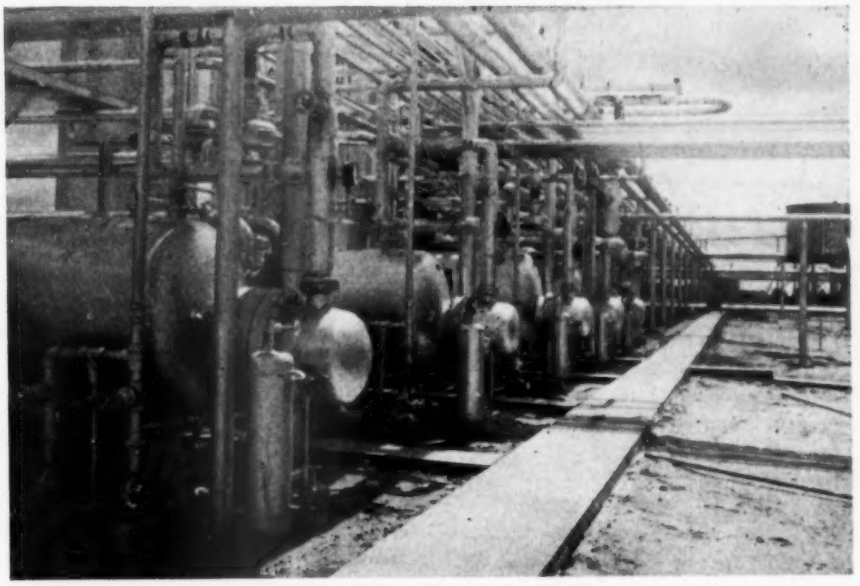
Of all the ingredients found in certain natural gas streams, possibly none are of greater importance and value in war or peacetime than helium, one of the so-called "noble" gases. Because of its chemical inertness, helium will not burn or explode. It has not been known to enter into any chemical reaction and in that it is the lightest gas known, excepting hydrogen, its scientific applications have become of invaluable help to humanity.

To make possible the difficult and important task of producing helium on a commercial scale, the Bureau of Mines assembled information relating to helium resources, perfected means for its extraction and trained the essential personnel. The U. S. Government uses about 98% of all the helium produced, and it is interesting to note that the Bureau of Mines is responsible for all of the present production. The saga of these scientific and technical accomplishments of the Bureau may be better evaluated when some of the more important uses of helium are considered.

Whether ascending to record heights in the stratosphere balloon or descending to the greatest depths of the sea ever visited by man, these operations find the use of helium unique. Today helium is used to inflate blimps used in anti-submarine patrol, fill barrage and meteorologic balloons, make diving and caisson operations less dangerous, relieve human suffering, enable war industries to weld magnesium and other metals for airplane construction, and aid war activities in many ways. Tomorrow its use in promoting science, industry, transportation, and medical treatment will only be limited by the scientists' ability to effect its maximum value.

Fear has been defined as "lack of confidence." Certainly, the lack of confidence recently voiced in many circles relating to our future petroleum reserves is not justified in view of the scientists' record to date. Scientific achievements in the past suggest that, as new problems arise in the exploration for and development of petroleum deposits throughout the world in locations heretofore considered difficult or impossible to pursue, their solution will not be wanting. It is true that the quantity of petroleum and its products concealed within the earth is of a definite magnitude and that it is not being replaced as produced. Thus the scientists' activity is necessary and of value in securing a maximum recovery and efficient use of this natural resource during its productive period.

As we draw near the end of our world petroleum resources, which does not appear imminent in our normal span of life, we are assured not only of constantly improving products but also of satisfactory substitutes produced from our enormous stores of other natural material resources—all to be realized through the technologists' accomplishments.



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WIDENING HORIZONS

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Industrial Research Should Be the Keystone In Our Postwar Preparedness Program

THERE seems to be general acceptance of the belief that the United States, after this war, will have to maintain itself in a state of military preparedness for even immediate emergencies. Our geographical position is no longer a protection, we are told. It also is assumed that the next great war will be directed first against our own country, because in two instances we have shown our great power to wage war on a vast scale once we are organized for that purpose. On the next occasion we may not have time to prepare ourselves.

The plans now discussed for keeping our country strong enough to protect itself from even sudden military aggression include maintaining the strongest if not the largest navy, a mobile army, universal military training and the support, by government subsidy if necessary, of essential industries such as aircraft manufacturing, synthetic rubber and chemical plants, among others. Little has been said to date, however, of the important place which industrial research will assume in our future military preparedness program.

There are many illustrations of the great industrial contributions in the present war which would have been impossible except for the knowledge acquired from the established research programs of many individual companies and industrial institutions. That we are able to supply now more than ten-fold the volume of aviation gasoline made before the war, and of a much improved quality, stems directly from the research programs many oil companies had privately carried on for years. The technology of the synthetic rubber program has the same type of origin. The technique for large scale production of planes, tanks and ships was not born in hastily called conferences of company executives and government officials. The methods were conceived and developed through experimental programs in many cases set in motion years before.

In view of these industrial achievements, which are universally recognized, it is disturbing that the chief public discussion now of the place of research in our future preparedness program should come from those who advocate organizing research work nation-wide under government supervision and even direction. The latest evidence that such a program is in the minds of the government's planners comes from statements from Senator Kilgore of West Virginia and indicates that his proposal to regiment the technological manpower of the nation is far from a dead issue. Senator Kilgore will be remembered for his Bill S. 702, introduced in Congress in 1943, which stated as its purpose "for peacetime progress and prosperity" to "mobilize the scientific and technical resources of the nation and to establish an Office of Scientific and Technical Mobilization," among other aims. Research institutions and their work and their acquired knowledge were included in scientific and technical resources as defined in this bill, on which no action was taken by Congress.

The new draft of his bill has not been finally prepared, the senator told the Indiana Engineering Society in a recent address in Indianapolis. However, he stated, it conceived a National Science Foundation, to consist of a director appointed by the President and a board of 10 members, broadly representing the scientific and technical interests of the government, industry, labor, agriculture, education and the consuming public. Except for the co-ordination of Federal research, he stated, it would impose no controls on existing research organizations, private or non-profit.

Analysis of the provisions of this new Science and Technology bill must await the publishing of its text. Fundamentally, however, there are many arguments for the continuance of industrial research on its present established lines and entirely free from any outside control or supervision, if it is to serve the nation to the maximum in our future military preparedness program.

Any future war, even more than this present one, will call upon the entire industrial resources of the nation. Industrial research, paralleling the advances in actual industrial enterprise, can better prepare for converting technological improvements to wartime purposes than can a research program conceived and directed by the government or other outside agencies. The methods and processes developed for new and improved products must be capable of large volume production, from existing plants if possible and from raw materials abundant in supply. This is the goal of industrial research, whether such products are for peacetime utilization or to aid in making war.

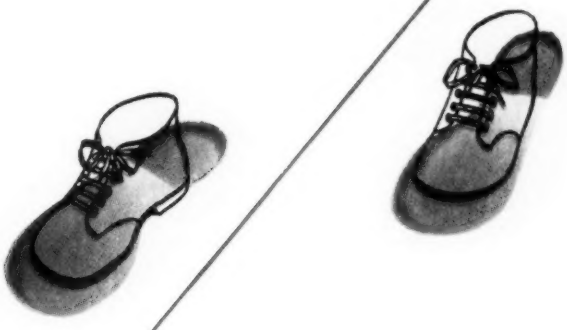
In industrial research, because of the profit incentive, the tendency is for important discoveries to be brought into practical application as rapidly as possible, even though the necessary further development work is costly. In our own industry, it is said that, after the discovery of the principle of cracking, over $500,000,000 was spent on thermal cracking before it was commercially practicable to crack heavy oils into gasoline. What official or agency would assume the responsibility for appropriating this sum for a single project in a government-directed research program? The discovery of the cracking process, however, in effect saved 18 to 20 billion barrels of crude, equal to approximately our present proved crude reserves.

Research by governmental agencies, even though its aim were our national security, would be subject to political pressure to direct it into one channel or another, as favored by some strong political group in Congress, and regardless of sound technological grounds. The fact that financing of a project is assured through government support makes it more difficult than in industrial research to keep the work parallel with practical developments in a given field. In the former case, research is likely to be continued long after a problem has ceased to be important because of new developments in an industry.

It is not to be construed that there is no place for government research in a national defense program. It is the logical sponsor of studies in fields such as agriculture and forestry, where the public interest is large in relation to the means of private companies to carry on such work, and of investigations of natural resources and the methods of their recovery. Military branches also have their own fields for research.

None of these, however, can take the place of industrial research in providing the plans and blueprints for the conversion of the nation's industries from volume peacetime to volume wartime production of the most modern instruments of warfare. Industrial research should be left free to serve this purpose.

IMPORTANT FIRST STEPS



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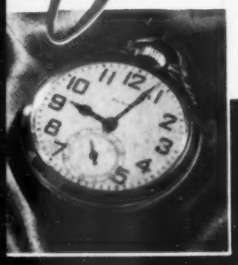
Precision

IN BIG THINGS TOO



Stainless steel bubble trays and caps being installed in *stainless* clad fractionating tower.